POWER

Volume 63 New York, June 8, 1926 *No.* 23

Work

IT IS hard work to work hard, but Oh! the joy of getting things done.

There is a heap of satisfaction in being caught up with one's work, of having no neglected task nagging at one and marring one's leisure and rest.

There is nothing more productive of peaceful, restful satisfaction than the pleasing consciousness of duty done.

This for the ordinary tasks that go with living and are just a part of the day's work.

But the real joy of working is seeing something in which one is interested getting done, in seeing one's ideals realized.

An engineer who had worked his way up out of the engine room and been assigned to responsible work in Africa, where he was killed in the Boer War, talked to me of the thrilling interest that he formed in conceiving a machine for some purpose, in working out its details and then seeing it come out in iron and steel and settle down to the job for which it was designed.

There is a lot of drudgery that must be done in order that man may live upon his present plane of comfort and of culture. Armies of men, and women, must spend their days in performing onerous, repetitive mechanical operations in the product of which they have no particular personal interest.

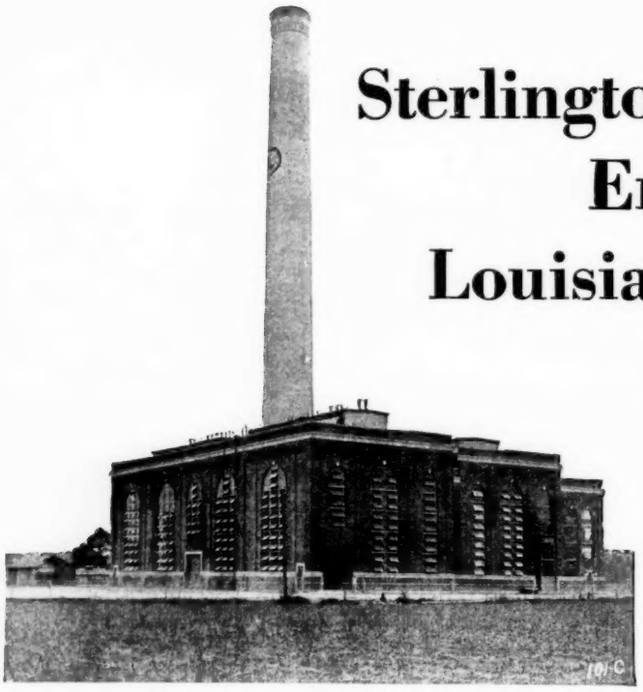
Power-driven machinery has reduced the severity of this class of labor both in the effort involved and in the time that one must serve daily in order to earn a living.

And most such operations become so subconscious, require so little mental activity, that an active mind could do wonders for itself in the meantime.

But the man who limits his work by his endurance and not by the clocks, the man who feels a sense of satisfaction with every lift and blow and surveys his completed task with the pride of accomplishment, is the man who has a personal and not a per diem or piecework interest in what he is doing.

F. R. Low

Sterlington Power Station Erected in Louisiana Gas Fields



First Section of Sterlington Station

CHEAP fuel responsible for simplicity in design and low installation cost; floor area only 0.81 sq. ft. per kw. Operation at over 300 per cent rating on natural gas unusual. Provisions made for extension to 200,000 kw.

THE first section of the Sterlington power station of The Louisiana Power Co. was placed in regular operation early in December, 1925. It is laid out for extension to 200,000 kw. or more, but the initial installation of 30,000 kw. was dictated by a market much smaller than that now available through consolidation with Electric Bond & Share Co. interests. The station is in the heart of the natural gas fields of northeastern Louisiana about fifteen miles north of Monroe, and on the Ouachita River, which provides an ample supply of condensing water.

This station is probably the first superpower development to be predicated on the supply of cheap fuel from a single large natural gas field. Reserves of two trillion cu.ft. are in sight, but power must compete with other industries in the use of the gas. A long life of the field seems assured, well exceeding the usual life expectancy of a power plant, but the very limitation in life of the field emphasizes the importance of fixed charges in the cost of power.

Having a particularly cheap fuel, the design of the plant was controlled, first by cost of construction, second by simplicity and ruggedness in operation and only incidentally by efficiency in fuel consumption. No refinements were added to the plant for the sake of efficiency, but nevertheless the operation to date indicates a fuel consumption of about 18 cu.ft. of natural gas per kilowatt-hour net output, or less than 17,000 B.t.u. per kw.-hr.

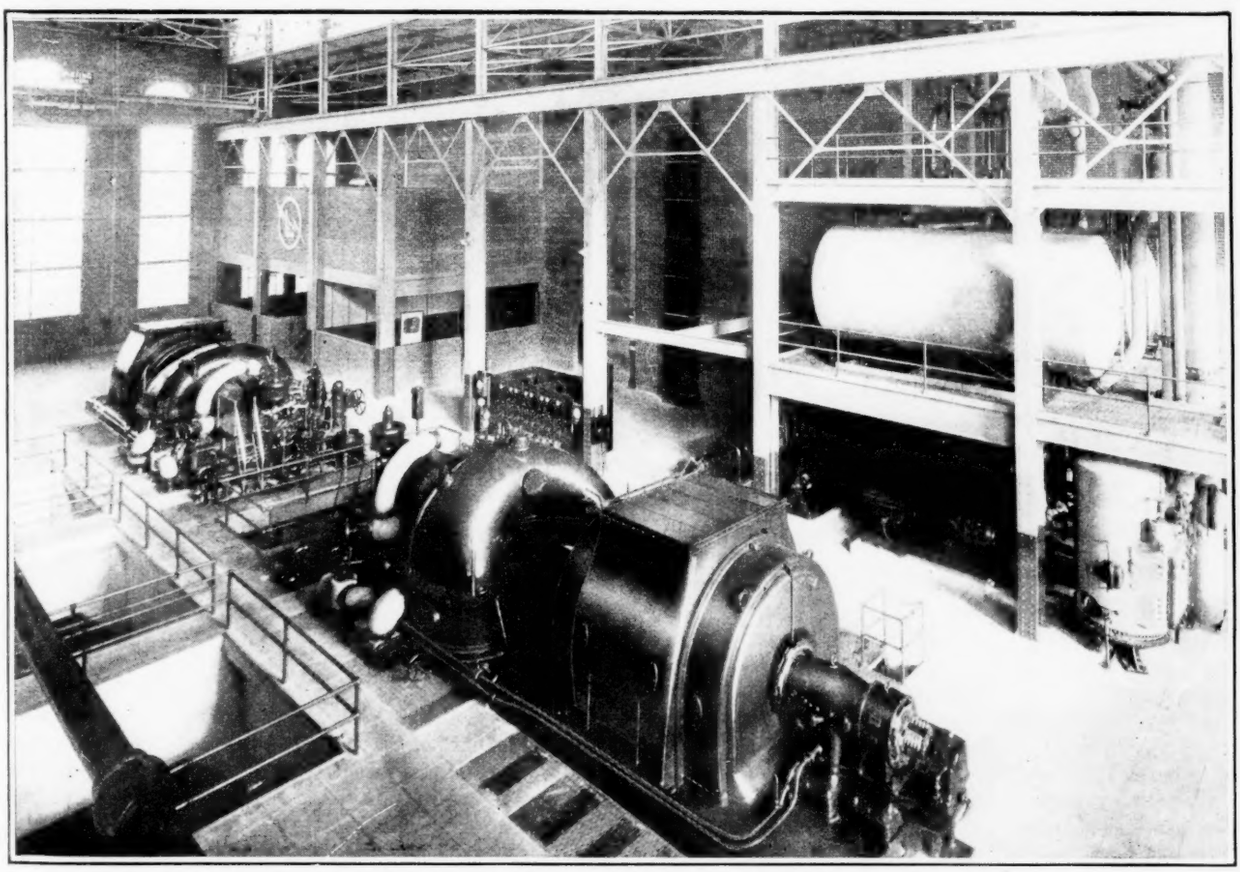
The designers of the plant were confronted with certain natural and other limitations. The Ouachita River at the site has a range of 40 ft. from flood to low water with the navigation dams open. Foundation conditions were not unfavorable, but the presence of wild gas at high pressures was a source of much concern. The summer river temperature at times exceeds 90 deg. F., and no available supply of water is suited for boiler feed when operating at high overloads. Navigation on the power-station side of the river could not be interfered with. There were no available data based on experience to encourage the belief in the possibility of high boiler overloads with natural gas as a fuel, and much discouraging experience was uncovered. Winds of hurricane velocity are frequent in the district, making high stacks undesirable.

The effect of river and foundation conditions on design is at once apparent. The most unusual feature is the disposal of condenser discharge. Instead of the usual tunnel for the entire station, present and future, a 72-in. pipe 320 ft. long carries the warm water from the present section across the bed of the river well toward the far side. This was done not only on account of cost, but also because the government engineers were unwilling to permit the discharge near the navigation locks of the large quantities of water to be used by the ultimate plant. The station is located on the inside of a long bend in the river and the main current is on the far side; hence there is a decided advantage in the cross-river discharge.

This plant of 30,000-kw. initial capacity, including one spare boiler out of four, occupies a total floor area of about 24,200 sq.ft., or 0.81 sq.ft. per kw. This is believed to be a record for a plant of this size. A similar layout for the second pair of units of 60,000 kw. total anticipated capacity will require only 34,300 sq.ft., or 0.57 sq.ft. per kw.

The pressure of 275 lb. and superheat of 150 deg. F. are low for a new station. Here, first cost controlled, but the pressure and superheat were made as high as reasonable for the turbine frame used. A lower pressure would have been economically sound, except that it would have been somewhat awkward for the larger units to be installed in extensions to the station. The 15,000-kw. rating of each turbine is the largest output possible from the turbine frame chosen, allowing a reasonable margin of safety. This gave a low cost per kilowatt at a negligible sacrifice in efficiency.

The generators are wound with fields sufficient for

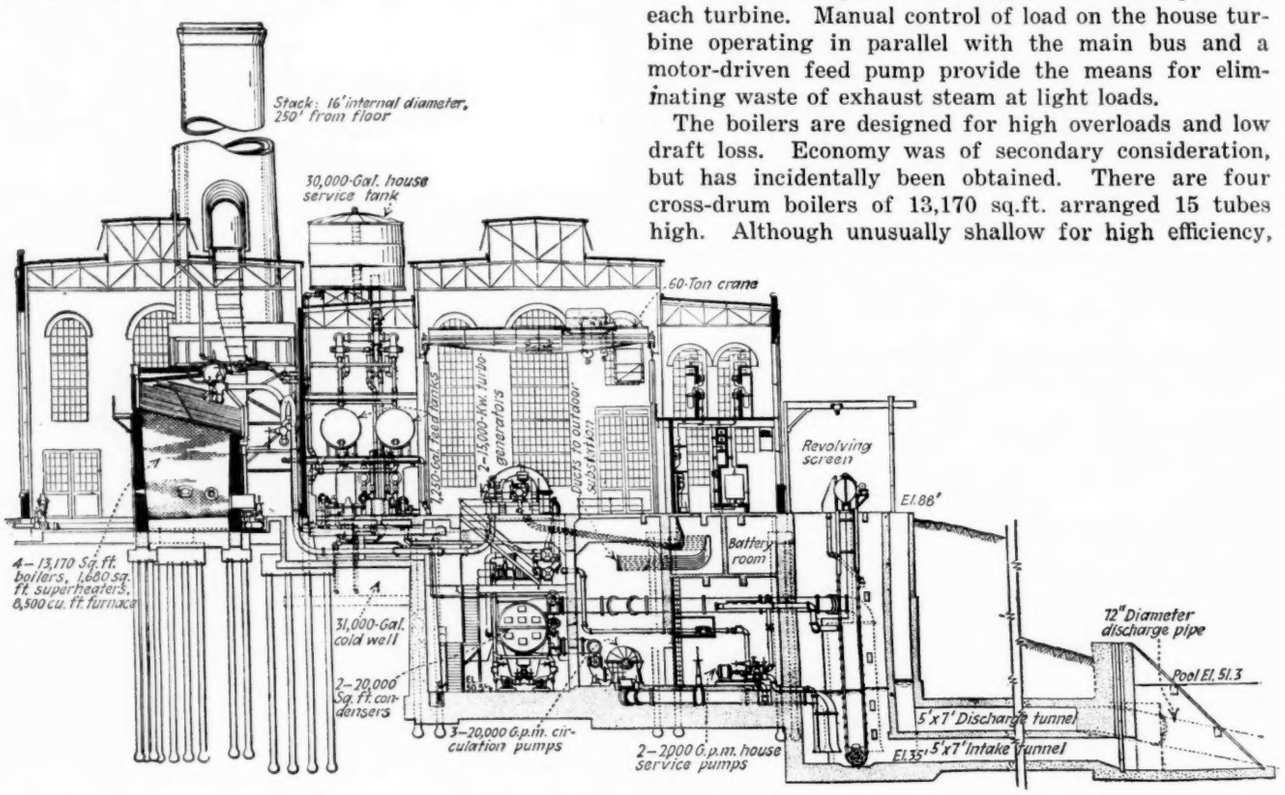


Lower view shows turbine room from south end of switchboard gallery
Upper view shows boiler-room operating aisle

15,625 kva. at 80 per cent power factor, and with armature windings for 13,200 volts, 60 cycles, three-phase grounded neutral. The large mileage of high-voltage transmission lines connected with the system assured a high leading power factor at full load, so the generators are properly balanced with the turbines. The most unusual feature of these generators is their demonstrated ability to carry with full stability a transmission line charging current at no load equal to 90 per cent of the full-load kva. rating. This characteristic was a necessary feature of the station design. The generators are cooled by a closed spray cooler located beneath the bedplate and arranged for emergency natural ventilation.

The feed-water system, illustrated by the diagram of steam cycle, was laid out to accommodate lack of sufficient exhaust steam from the house turbine and feed pumps and absence of suitable feed water. Two stage heaters per unit were installed to make up steam deficiency and a pair of evaporators to supply makeup water. High-heat-level evaporator condensers increase the possible extent of stage heating with its attendant efficiency. Open jet condensers are used for feed-water heaters. Exhaust steam from the auxiliaries and drips from the evaporator system and steam piping discharge into the heaters. Heater discharge temperature is controlled thermostatically through the amount of steam bled into the stage heater on the third bleed point of each turbine. Manual control of load on the house turbine operating in parallel with the main bus and a motor-driven feed pump provide the means for eliminating waste of exhaust steam at light loads.

The boilers are designed for high overloads and low draft loss. Economy was of secondary consideration, but has incidentally been obtained. There are four cross-drum boilers of 13,170 sq.ft. arranged 15 tubes high. Although unusually shallow for high efficiency,



Cross-section of present plant

The condensers of 20,000 sq.ft. each are small as judged by ordinary standards when 90-deg. water must be used, but here again the added efficiency of larger condensers would return only a small part of the added cost. Dirt was first feared with such small condensers, but there has proved to be sufficient fine silt in the water to keep the tubes clean. Water levels required a nozzle 12 ft. long between turbine and condenser. Three circulating pumps are provided and electrically operated valves control the interconnections so that any combination of pumps and condensers may be used.

Condenser auxiliary drive was laid out for simplicity of operation. Electric motors are used throughout, all driven at 2,300 volts by a relatively small house turbine with auxiliary supply from the main bus. All the condenser motors are started by throwing directly on the line. The main control is located on an auxiliary board adjacent to the throttles of the turbines, and there are separate circuits and oil switches for each motor. The watch engineer thus has full control over the condenser power, both its source and use.

this arrangement made it possible to install superheaters above the first pass.

The boilers were set over furnaces each of 8,500 cu.ft. in volume to provide ample combustion space for expected loadings at 350 per cent of rating. This gives a ratio of 0.65 cu.ft. of furnace volume per square foot of steam-making surface. Seven groups of natural gas burners are installed in each furnace in the wall below the mud drums. In operation these boiler units have demonstrated their ability to carry such overloads for long periods with efficiencies well above 80 per cent and a draft loss between boiler room and breeching of less than 1 in. of water. The relatively low stack, 250 ft. high above the firing floor, has proved sufficient.

The burners are in the back walls of the boilers. Control is manual, the entire fuel supply being controlled by regulating the pressure-reducing valves and gate valves near the wall opposite the stack foundation. The flue dampers are operated from the floor, but the burners are so designed that in a considerable measure air proportioning is automatic through gas pressure. A full

set of boiler meters provides the operator a sufficient guide for proper adjustment as well as a check on performance.

The piping system was laid out for 400 lb. and 700 deg. total temperature. Simplicity and mechanical flexibility were the keynotes. Torsional flexibility was provided when possible. Each turbine is connected as directly as possible to two boilers and the two mains suitably interconnected. Auxiliary steam is obtained from either of the two unit mains. A loop feed-water system is provided, a feed pump normally supplying each leg of the loop.

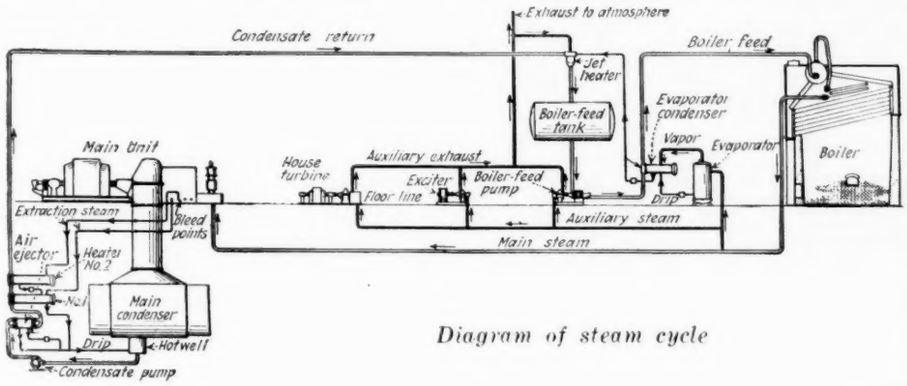


Diagram of steam cycle

The ultimate 13,200-volt switching system contemplates: A group of two or three feeders for each generator normally supplied by a group bus; a transfer bus to which any gencrator or feeder can be connected; and a synchronizing bus to which the group buses are connected through suitable current limiting reactors. The synchronizing bus and reactors will not be installed until the station is extended. The group and transfer bus and cell structure is installed for the first two units, but the auxiliary feeder oil switches are omitted. Disconnecting switches are provided instead. The group buses are installed complete with all oil and disconnecting switches, and either generator may be connected to the transfer bus through an oil switch now installed.

The auxiliary 2,300-volt switching system is made up of inclosed truck switches. The motor circuits under control of the watch engineer at the turbine throttles are hand operated. All other circuits are electrically controlled. The station lighting, condenser auxiliaries and other essential auxiliaries are connected to one section of the bus fed by the house turbine. Less essential auxiliaries are supplied from a bus section fed by the station auxiliary transformers.

The main control board is of the usual bench type with instruments and relays on a vertical board to the rear. A single storage battery supplies power for switching operations, but provision is made for a later duplicate battery installation. Auxiliary boards and the high-tension control board are suitably grouped around the main board, space having been provided for additional boards in anticipation of growth to meet new load conditions.

Each turbine has a direct-connected exciter and there is a spare steam-driven exciter. Any generator field may be connected either to its own exciter or to the spare by means of electrically operated switches controlled from the main control board. Field rheostats are electrically operated either under manual control or by automatic voltage regulators as required.

This station was designed and constructed for the Louisiana Power Co. by Ford, Bacon & Davis, Inc., of New York, the principal items of mechanical equipment, and the equipment manufacturers are listed in the table.

PRINCIPAL MECHANICAL EQUIPMENT OF STERLINGTON POWER STATION

TURBO-GENERATOR PLANT

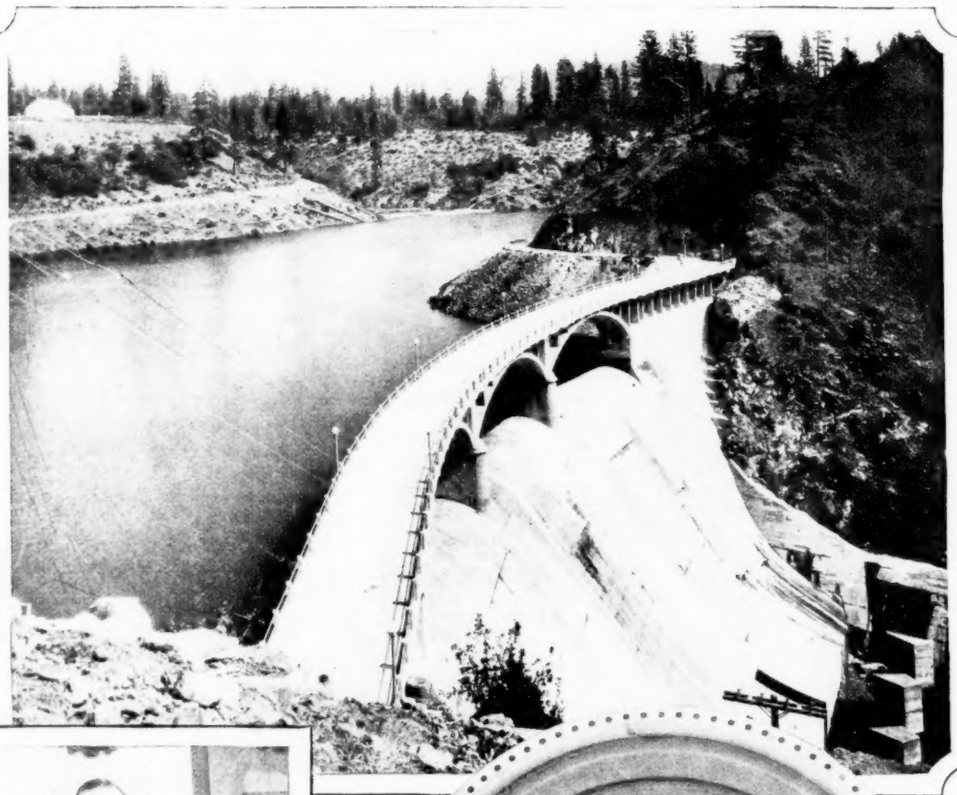
Two 15,625-kva. turbo-generators, with direct-connected exciter, 80 per cent power factor, 13,200 volts, 3-phase, 60 cycles, grounded neutral	Westinghouse Elec. & Mfg. Co.
Two 20,000-sq.ft. surface condensers	Westinghouse Elec. & Mfg. Co.
Two 24-in. relief valves for condensers	Westinghouse Elec. & Mfg. Co.
Three 20,000-g.p.m. centrifugal circulating pumps	Westinghouse Elec. & Mfg. Co.
Four 500-g.p.m. condensate pumps	Westinghouse Elec. & Mfg. Co.
Four LeBlanc steam-jet air pumps each 22.1 cu.ft. per min.	Westinghouse Elec. & Mfg. Co.
Two intercoolers, 4-in. inlet and outlet	Westinghouse Elec. & Mfg. Co.
Two after-condensers, 4-in. inlet and outlet	Westinghouse Elec. & Mfg. Co.
One 625-kva. house turbo-generator with direct-connected exciter, 2,400 volts, 3-phase, 60 cycles	Westinghouse Elec. & Mfg. Co.
One 75 kw. turbine-driven exciter 250 volts d.c.	Westinghouse Elec. & Mfg. Co.
Two 42,500-cu.ft. per min. Spraco recirculating air coolers	Spray Engr. Co.
Twelve motor-operated condensing water gate valves, 30- and 36-in.	Crane Co.
One 350-gal. per hr. turbine oil purification system	Westinghouse Elec. & Mfg. Co.
One lubricating oil heater, 350 gal. per hour	Griscom-Russell Co.
Two 1,660-gal. oil-storage tanks	Staten Island Shipbuilding Co.

BOILER PLANT, PIPING, ETC.

Four 1,317 sq.ft. cross-drum water-tube boilers	Springfield Boiler Co.
Eight Reliance water columns	Springfield Boiler Co.
Four 1,680-sq.ft. superheaters	Superheater Company
Four boiler settings, 8,500 cu.ft. furnace volume (Labor only)	Bishop Contracting Co.
175 M firebrick	Walsh Fire Clay Products Co.
Four sets boiler insulation	Celite Products Co.
Twenty-eight gas-burner units	Duquesne Burner Service Co.
Two fuel-gas regulators, 240,000 cu.ft. per hr. each	Equitable Meter Co.
Breechings, flues, uptakes, air ducts, etc.	Connery & Co.
Three 500-g.p.m. boiler-feed pumps	Worthington Pump & Machinery Corp.
Two 160-hp. feed-pump turbines	Westinghouse Elec. & Mfg. Co.
Four extraction heaters, 650 sq.ft. each	Croll-Reynolds Engr. Co.
Two Contraflo evaporators, 133.5 sq.ft. each, 7,600 lb. per hr.	Wheeler Cond. & Engr. Co.
Two evaporator condensers, 333 sq.ft. each	Wheeler Cond. & Engr. Co.
Two barometric condenser feed-water heaters, 16-in.	Wheeler Cond. & Engr. Co.
Two 7,250-gal. feed tanks	Staten Island Shipbuilding Co.
Eight Copes boiler-feed controllers, 3 in.	Northern Equipment Co.
Two 447,000 lb. per hr. boiler feed-water meters	Simplex Valve & Meter Co.
Four sets boiler meters, steam, air flue gas, pressure gage, etc.	Bailey Meter Co.
Two 2,000 gal. per min. house service pumps	Gould Pumps, Inc.
All steam, feed and service water valves	Crane Company
All steel fittings	Walworth Co.
One 20-in. relief valve	Cochrane Corp.
One 375-gal. blow-off tank	Staten Island Shipbuilding Co.

MISCELLANEOUS

One 60-ton traveling crane with 10-ton auxiliary hoist	Whiting Cor
One concrete stack 16 ft. inside diameter 209 ft. above elevated foundation	General Concrete Const. Co.



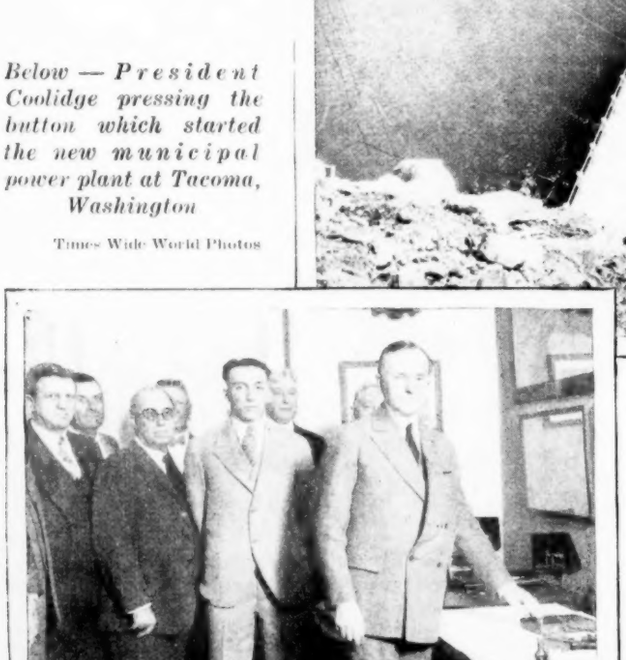
Right—Pit River No. 3 dam of Pacific Gas & Electric Company, San Francisco

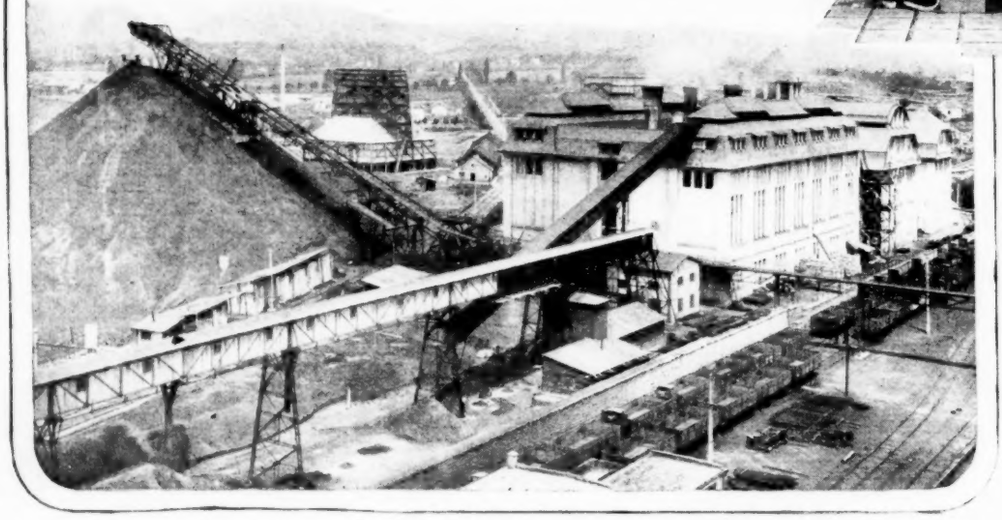
The waters of Lake Britton, diverted by this 110-ft. dam, drive three 30,000-kw. turbo-generators

Photo by Ewing Galloway, N. Y.

Below — President Coolidge pressing the button which started the new municipal power plant at Tacoma, Washington

Times Wide World Photos





Above — Low-pressure casing of 77,000-kw., G. E. turbine for Crawford Avenue Station

Left — New power plants, such as this at Urzog, mark Hungary's industrial progress

Photo by Ewing Galloway N. Y.

Why Higher Pressures Are Advantageous for Industrial Plants

Higher Initial Pressure Makes Possible Increased Extraction Pressures and Opens the Way for the Use of Bled Steam for Even High-Temperature Process Work

BY WALTER SLADER

WHILE there are many processes in connection with textile finishing and other industries for which steam at pressures under 10 lb. is suitable, there are also many processes requiring temperatures higher than those of steam at these low pressures or demanding large quantities of steam to be furnished quickly, and if pipe lines are long or limited in size, the rate of flow without excessive pressure drop becomes inadequate.

The use of exhaust steam in general, and particularly some extraction installations, has fallen into ill repute because of this, and many executives have hesitated to make such installations because of the fear that some process would be thus hindered—a thing that no manager can tolerate.

If the pressure at which steam is extracted from a turbine is relatively high, either the quantity extracted must be limited or the condensing rates of the machine, especially at part loads, impaired, and these are often more important than has been realized.

Why an Extraction Turbine Is Used

The extraction turbine is used because it can be made automatically to deliver as wanted, anywhere from none to 98 per cent of the throttle steam at the extraction nozzle. This ability to meet wide variations in steam demand is a convenience that fits our industrial needs as nothing else will, but sometimes too much attention is paid to the 98 per cent condition and too little to the zero or 10- and 20-per cent conditions; while almost always both need to be kept in mind if good results are to be maintained. If the steam demand continued steady throughout the time during which power is required, one would not use an extraction machine, but rather the much simpler non-condensing turbine, with a suitably high back pressure.

As an example of the advantages of high initial and extraction pressures, consider a recently designed turbine unit of standard proportions intended for operation with the following conditions and results:

Capacity, 1,500 kw.; initial pressure, 200 lb. (gage) per sq.in.; superheat, 100 deg. F.; absolute exhaust pressure, 2 in. of mercury; automatic extraction at 10 lb. (gage) per sq.in.; full-load steam rate condensing, no extraction, 15.25 lb. per kw.-hr.; full-load maximum extraction, 54,500 lb. of steam admitted per hour, 53,500 lb. extracted.

In expanding from 200 lb. gage to 2 in. of mercury absolute under ideal conditions, 1 lb. of steam would make available 363 B.t.u. for conversion into useful work. The actual machine, however, running at full load with no extraction, uses 15.25 lb. of steam to produce 1 kw.-hr., which is 3,413 B.t.u. In other words, in the actual turbine, 1 lb. of steam develops 225 B.t.u. of useful work. This is 62 per cent of the ideal work available; that is, the "engine efficiency" of the turbo-generator is 62 per cent.

When the turbine is delivering extraction steam, the situation is a little more complicated. At full load and full extraction, 54,500 lb. of steam per hour passes the throttle, of which 53,500 lb. is extracted, while 1,000 lb. passes on to the exhaust. Meanwhile, 1,500 kw. is developed as useful power. Most of the steam expands from 200 lb. gage to 10 lb. gage, and in this drop under ideal conditions each pound would make 174 B.t.u. of useful work available. About 92 B.t.u. of useful work is actually done by each pound of extracted steam—about 53 per cent of that theoretically available. Under these conditions the steam that goes completely through the turbine passes to the condenser with 6.7 per cent of moisture and that leaving through the extraction nozzle has about 15 deg. F. superheat and a volume of 16.61 cu.ft. per lb.

Effects of Higher Pressure

Until recently this machine would have been thought a high-pressure unit, but it is now so designed that it can readily be built for any pressure up to 400 lb. Accordingly, suppose that the boiler pressure is raised to 300-lb. gage, or, say, an initial pressure in the turbine of 285 lb. gage with 120 deg. F. superheat and a condenser pressure of 2 in. of mercury as before and an extraction pressure that would allow the full load to be produced while extracting about the same quantity of steam. Suppose further that the same quantity of heat (92 B.t.u. per lb.) is converted into power by the extracted steam in a turbine of unchanged efficiencies. There would be available from this greater pressure and temperature fall 391 B.t.u. per lb. of steam that passes to the exhaust, and of this 242 would be converted into useful work. The steam leaving the last turbine blades will carry 6.5 per cent of moisture, and that passing out through the extraction nozzle at about 24 lb. gage will be superheated about 35 deg. F. and will have a volume of 11.47 cu.ft. per lb.

Of course, for any actual case turbine efficiency would vary somewhat because of change of range and design features of the machine chosen, but the purpose here is merely to indicate approximately how extraction pressure can change with throttle pressure, without departing from proportions that past experience has shown are good.

The accompanying table compares the results for the 10- and 24-lb. extraction pressures on the assumption that the maximum of 53,500 lb. per hour is to be transmitted through a pipe line of 500 ft. effective length, including fittings. Pressure drops have been taken from a chart based on the Babcock formula.

If it be further assumed that the process demands a pressure not lower than 8 lb. gage, a glance will show that the 14-in. line is just large enough for the 10 lb. pressure, that smaller sizes cannot be considered, and that the length of run would have to be less than half before the 12 in. could serve. For the 24 lb. pressure the 12-in. line will be a proper choice, to keep a moderate pressure drop at all times, or if the largest quantity is to be required for long periods, but now there is more margin between the necessary and the available pressures. Often, for this kind of service, maximum values greatly exceed averages and last for only a short time. A study of these and other conditions will decide whether the 10-in. or 12-in. pipe is best adapted for the service. The smaller will, of course, cost less.

COMPARISON OF TWO EXTRACTION PRESSURES

Pressure	10	24	lb. per sq.in. gage
Temperature	255	300	deg. F.
Specific volume	16.6	11.5	cu.ft. per lb.

Pipe Size, In.	Pressure Drop for 500 Ft. Run		Terminal Pressure		Steam Velocity Ft. per Min.		B.t.u. Loss per Ft. Length of Covered Pipe		Pipe Surface for 500 Ft. Runs, Sq.Ft.
	p=10	p=24	p=10	p=24	p=10	p=24	p=10	p=24	
14	2.0	1.3	8.0	22.7	7,120	5,730	287	...	1,965
12	4.6	3.1	5.4	20.9	10,000	8,070	...	309	1,670
10	11.9	7.6	—1.9*	16.4	14,000	11,300	...	260	1,408

*Vacuum

If the 12-in. line is required, the probable heat loss will be slightly more (about 22 B.t.u. per foot per hour) than from the lower pressure line. If 10-in. pipe can be used, the heat loss will be less, as will often be the case when services at different pressures are compared.

This is a convenient point for considering an important phase of the matter. Just how large are the peak steam loads? How long do they last? How much do they vary from the average load? What could be done to reduce them and is it worth while?

Every plant manager knows what it means for economical production to be obliged to manufacture 5,000 articles this week and 2,500 per week for the next three; but sometimes not much thought is given to what it means for the power plant when, to meet some process demand, the boiler house must furnish steam at the rate of 50,000 lb. per hour for fifteen minutes, and at the rate of 25,000 lb. for the rest of the hour.

Why Peak Loads Cost Money

More in times past, but even now too often, this has been supposed to be principally influential in getting the lazy fireman to his feet and thus promoting activity. It does. It also results in putting altogether too much air into the boiler furnace for a long time after the peak is over, with lower boiler efficiency. It causes steam pipes, all through the plant, to be larger than they would need to be; with higher cost for pipe, valves and covering and increased heat loss to rooms already too hot for comfort.

It is not intended to suggest that peaks can always be done away with, or that it will always be worth while to attempt it, but, to the extent that it can be done without undue cost, it will be a real step toward better plant economy and less money will be idle in large pipe lines. Attention has been given to this point in Europe, and the fact that they have apparently found such attention profitable and are using many expedients, such as accumulators, to smooth out loads, may be worth our study.

Available heat sources must be considered with respect to their temperature. Some processes must operate at high temperatures, and hence cannot utilize low-level heat, but many processes need or can use low-range heating operations. The maximum use of low-level heat will not only save what otherwise would be wasted, but will frequently go a good way to help smooth humps out of the high-temperature demands.

Many industries have use for heated water in large quantities at temperatures not higher than 100 to 120 deg. F. Not a few have made large savings by varying the circulating-water quantity and vacuum on a condensing turbine, and delivering this water, heated to the required temperature, for process uses. If part or all of this water is needed at a higher temperature, the first stage of heating could be performed in the condenser and the remainder in heaters supplied with extracted steam.

If reasonable hot water storage capacity were provided, with the pumps, heaters and other equipment assembled in the power house, where they would be in charge of men best fitted to give them proper care and carry out a proper performance schedule, boiler-house operation could be made more steady and economical, steam turbines could be chosen to operate at better average efficiencies and process steam lines could be made smaller and worked more of the time at their capacity. Such an arrangement would not always be desirable, but some modification could often be made valuable.

Some Advantages of Higher Pressures

The choice of higher throttle and extraction steam pressures makes it possible to carry steam longer distances, due to the wider margin between the pressure available and that necessary for the desired work. The extent to which this will be advantageous depends considerably on the necessary length of steam lines, and similar restrictions. Higher pressures will bring some processes comfortably within a working range which formerly were on the border line or clearly outside; and will enable better advantage to be taken of opportunities, such as a demand for steam in some process at higher pressure, such as 60 or 100 lb. per sq.in. and for which a second extraction system can be provided. A high-pressure extraction turbine will have better operating efficiency and will call for smaller and less expensive steam lines for distribution. If maximum steam demands can be limited, the last two conditions can be still further improved.

The most serious disadvantages of increased pressures are, for a new plant, the increased cost of boilers, equipment and turbine; and for old plants, this, plus two different steam pressures that would have to be safeguarded and arranged to work together; a thing that has, however, often been done successfully.

An industrial plant, provided it has an equally good load factor, can obtain the same economy and advantage as the public-utility station from the use of steam extracted at a range of pressures to heat feed water to a temperature nearly corresponding to boiler pressure. An industrial plant that operates eight hours a day cannot, however, afford to pay as much for refinements as one which works 24. This factor, of how many hours per year equipment has an opportunity to make earnings, must enter into all our calculations; but, when each case is judged on its merit, decision will be easy.

Any considerable-sized plant, when building new or making important additions, no longer need hesitate to raise boiler pressure to 300 lb. if the change is advantageous. Little argument should be necessary to show that in many cases an increase of pressure for

process lines from 10 to 20 or even 30 lb. would carry with it real advantages.

Some engineers maintain that even pressures which now seem extremely high carry greater advantages for the industrial plant than for the central station, and that there is no reason why such pressure should not be used.

It is easy to agree that the largest and best organized industrial plants should find no special difficulty in operating any equipment economically, but even for those who have a carefully chosen group of men for handling power-plant affairs, this department is a relatively minor one when compared with others; and many industrial companies have not thus far thought it advisable to maintain a power plant force with the special training and skill for handling the more extreme pressures.

For many such companies, however, there yet remains a field promising large returns, through bringing up the average monthly performance of reasonably good plants they now have or may build along relatively conservative lines, to a good deal more nearly match the results of short-time tests.

German Arrangement for Burning Pulverized Coal Over Stokers

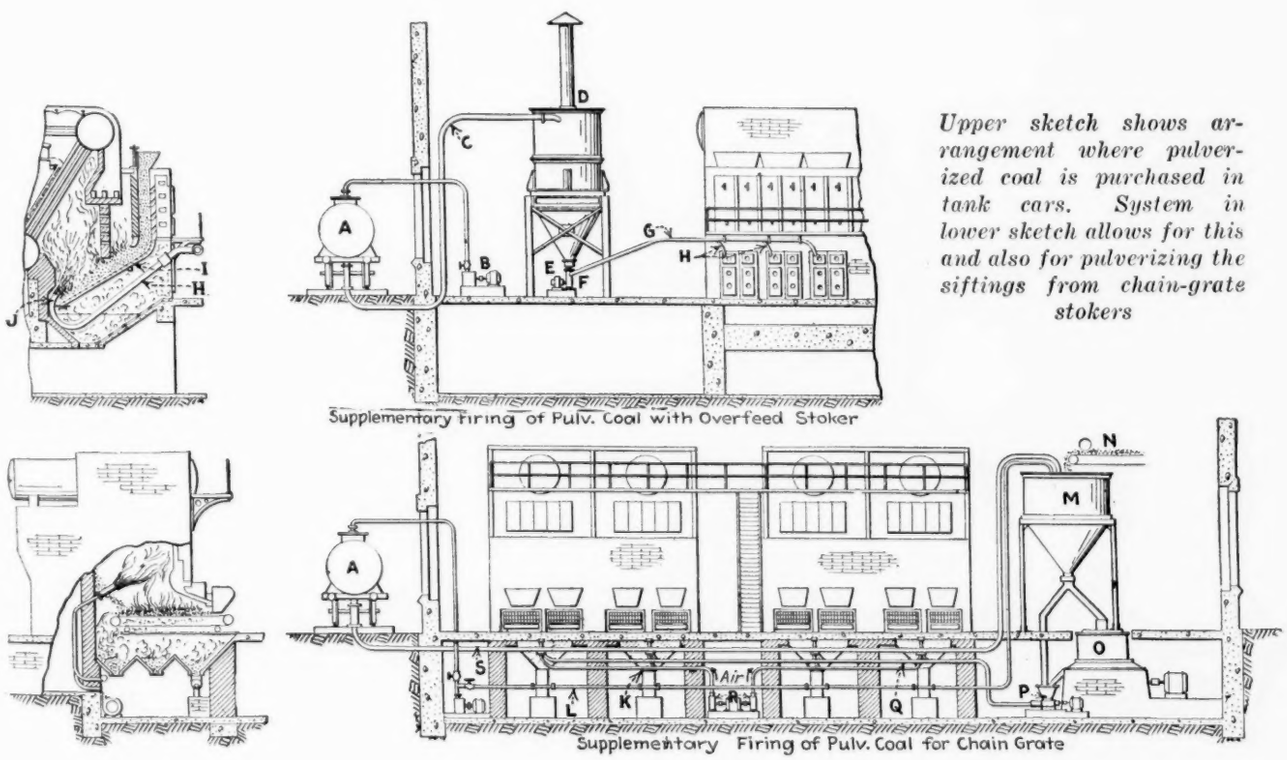
A SPECIAL system for burning pulverized coal as a supplementary fuel to increase the output of stoker-fired boiler furnaces has been developed in Germany. It may be applied to plants that purchase pulverized coal delivered in special tank cars, or a suitable unit mill may be also included for pulverizing raw coal and ashpit siftings on the site.

The upper sketch shows the system applied to boilers fired by overfeed stokers. Pulverized coal is unloaded from tank car *A* by means of compressed air obtained from compressor *B* and is conveyed through the pipe line *C* to the storage bunker *D*. An adjustable gate *E* regulates the quantity of fuel that enters the blower *F*, which forces the mixture of fuel and air through the pipe line *G* and branch connections *H*. From these it passes underneath stoker grates *I* to the burners *J*, installed in front of the bridge wall and facing the furnace front. The burners may be installed without shutting down the entire plant. It is claimed that an increase of from 10 to 20 per cent in steam output can be obtained in boilers having a relatively small furnace volume and that there will be a gain of 30 to 40 per cent if the system is applied to boilers with a larger combustion space.

The lower sketch shows the system applied to traveling-grate stokers. In this case the siftings from the stokers are collected and pulverized for burning them under the boilers during peak load. This dry combustible drops through collecting hoppers *K* into the pipe line *L*, which conveys it by means of compressed air into the receiving coal bunker *M*. Raw coal may also be delivered into this bunker by the belt conveyor *N*.

The coal is fed by gravity to the mill *O*, which pulverizes it, and is then forced by two fuel pumps *P* through pipe line *Q* to the boiler furnaces. Regulating valves are provided to control the fuel and air supply from the blowers *R*, which carry the mixture of fuel and air to the burners. When purchased, pulverized coal is received in tank car *A*, it is carried by air through pipe line *S* to the bunker *M*, from which it bypasses the mill and enters the fuel pumps *P* direct, by gravity.

It is claimed that the system is moderate in first cost and that it makes the installation of additional or stand-by boiler equipment unnecessary, since it provides ample flexibility and the required extra capacity for increased load demand.



Upper sketch shows arrangement where pulverized coal is purchased in tank cars. System in lower sketch allows for this and also for pulverizing the siftings from chain-grate stokers

Are Welded Pressure Vessels Safe?

By E. E. THUM*

IN PRESENTING this brief for welded pressure vessels the author, who is well qualified by training to advise authoritatively on the subject, outlines the procedure control and inspection that should result in safe and satisfactory welds. It should be noted that he is dealing with pressure vessels in general and does not discuss specifically welding on parts of steam boilers subject to stress.—EDITOR.

AN EDITORIAL in *Power* for Nov. 10, 1925, on this subject has started a series of interesting letters to the editor. Nearly all of them discuss but one phase of the problem and seem to assume that the personal skill of the welder is the one important thing to watch.

Unquestionably, the precautions that insure safety in a riveted vessel will do the same for a welded vessel. No responsible person would purchase a pressure vessel from a firm that had never made anything stronger than a hot-air duct, built according to the ideas of a tramp

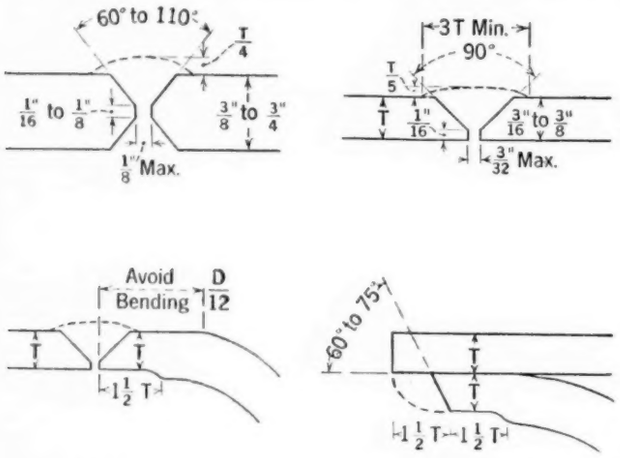


Fig. 1—Design of typical oxwelded joints

iron worker, constructed of the cheapest tank steel on the market, and installed, paid for and put in operation without inspection of any kind. Any pressure vessel, for holding any substance, gas, oil, air, water or molasses, made with any kind of a joint would be unsafe after such a history.

On the other hand, if a pressure vessel is designed by competent engineers, built in a shop that takes pride in its output and has equipment adequate for the job in hand, by men of proved ability working under correct supervision, and subject at the end to close inspection and proof test—then that pressure vessel would be safe whether made by riveting or by welding.

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It cannot reasonably be objected that these precautions are too numerous or too intricate to be practicable commercially. The six elements of "procedure control" for securing a satisfactory job of welding are no different from the principles of production engineering

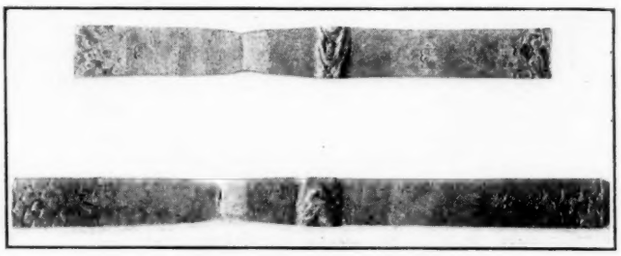


Fig. 2—Test pieces of firebox steel, welded with high-test rod

underlying the construction of any other structure, machine or appliance of equal importance. Let us list them and examine them more in detail.

Production Control

The elements of procedure control in welding are as follows:

1. A correct design of the article.
2. Secure proper metal for the work.
3. Verify the skill of the welder.
4. Provide necessary tools and shop appliances.
5. Insure adequate supervision.
6. Submit the completed article to close inspection and proof test.

As can be seen, these are nothing more than familiar branches of modern industry, namely:

1. Engineering.
2. Purchasing.
3. Employment.
4. Shop Organization.
5. Management.
6 Inspection.

Ordinarily, the purchaser of the equipment provides the first and last of these items, often by employment of consultants, while the shop that makes the equipment attends to the other four items. Therefore, the purchaser (if he is a wise business man) contracts for important equipment only from shops with correct facilities and of high reputation.

Ample information is now available on the various phases of procedure control in oxwelding, and is reinforced by experience of years with thoroughly satisfactory systems operating at high pressure. Consequently, one is enabled today to answer emphatically "Yes!" when asked "Are Welded Pressure Vessels Safe?"—"Yes, when made under correct procedure control."

Correct Design

It will be of interest to outline the facts and principles just mentioned, step by step.

It should not require much argument to convince one that it would be lazy engineering to take a design

developed by cut-and-try experience with riveted construction, and merely substitute welding at the joints. The original design must be made having in mind the method of joining, in order to achieve the advantages inherent to that particular method.

Fundamental Principles

Boiled down to its fundamentals, the principles of oxwelded design are simple and few in number.

1. Design to get thorough penetration without overheating. This calls for veeing the plate from one or both sides, if of more than moderate thickness.

2. Locate the joints so that bending, splitting or compound stresses are avoided, especially if impacts will occur. This requirement rules out lap joints and heavy reinforcement on one side of a single vee. Slight settlement on tank bottoms made by lapping the plates has caused much trouble and loss. It also rules that dished ends of pressure vessels should be fastened to the shell by butt joints some distance back of the knuckle.

3. Avoid overheating. This prohibits cross-welds. Stagger longitudinal seams, so that joints meet in tees instead of crosses. It also is a reason for double-vees on joints in heavy plate and a reason against welding pieces of widely different cross-section.

These general principles are modified by other considerations gained by experience, such as the ratio between the length of longitudinal to circumferential seams, the maximum thickness of plate to be welded, and so on. Space only suffices to note that these general principles have been well accepted, and are the basis of the provisions of codes for power piping, such as the one enforced by the State of Michigan. Sketches of approved joints shown herewith are taken from that code.

When advantages are taken of these principles of design, great economies in construction result. For instance, the wall thickness of any steel pipe from 3

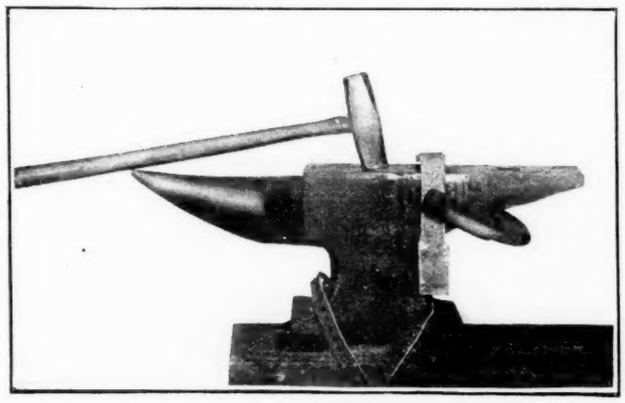


Fig. 3—Bending welded test piece over anvil

to 10 in. in diameter can be reduced $\frac{1}{16}$ in. without sacrificing any strength whatever, simply because the standard pipe thread digs that deep into the pipe. Oxwelding, therefore, saves a ton of metal for every 300 ft. of 6-in. pipe laid, over and above the weight of flanges, sleeves or other old-style fittings.

Responsibility for material for welding rests with the purchasing agent of the manufacturer. It may be briefly discussed under two subdivisions—steel plate and welding rod.

Ample experience shows that for best results only *low-carbon steel* of high quality should be used. Of course it is possible to make a weld in rail steel or even tool steel, but for important structures the carbon content should be lower than 0.25 per cent. This includes such well-known classifications as firebox steel, flange steel, ship plate and tank steel. Structural steel is also low in carbon.

Of the various classes of plate, firebox and flange are the highest in quality. Ship plate also has definite

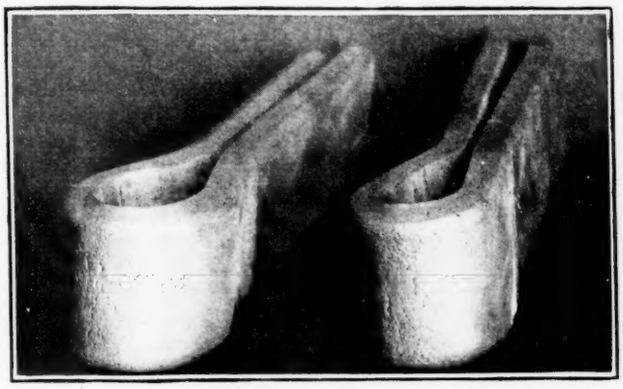


Fig. 4—Double-vee oxwelds bent double

specifications. However, tank steel may be almost anything that will roll into plate, and at times has poor welding qualities, either by virtue of high carbon or dirty structure. Either of these circumstances can be discovered by bending a strip of the steel around a pin equal to its thickness. If it cracks before bending flat it should not be used for important structures. This is a very simple test, yet excellent for indicating quality.

If high strength is desired, use none but first-quality flange steel, having tensile strength up to 65,000 lb. per sq.in. Welded joints can be made in such plate developing the full strength. Furthermore, 65,000 lb. per sq.in. is now about the limit of the strength of a double vee seam welded in a well organized shop with high-test rod.

These facts boil down simply to this: Use for welded pressure vessels only steel plate that will stand a severe bend test.

Material for Welding Rod

As to the welding rod. Four general classes, now specially made for oxyacetylene welding under careful supervision and test and widely sold by reputable manufacturers, are (1) mild steel, (2) iron or very low carbon steel, (3) nickel steel, and (4) high-test rod.

Mild steel is the least desirable of the four because it sparks considerably and some of these globules of burned metal, fallen into the joint, are later retained in the weld. Iron rods are much better in this respect; 3½ per cent nickel steel rod is used by many for high strength work and is satisfactory when care is taken to learn to weld properly with it. High-test rod is high in manganese and silicon, which oxidize during welding in preference to carbon, and readily slag off. It may be regarded as a "self-fluxing" rod capable of making weld metal containing up to 0.20 per cent carbon (therefore stiff and strong). One hundred per cent joints in firebox steel are made by oxwelding with high-test rod.

Welders can be hired or they can be trained. Perhaps it would be better to say, welders can be trained, for few welders are hired who do not require some training. That this training for repetitive or production work is not unduly long or expensive may be gathered from the statement that crews for the construction of long pipe lines, requiring a hundred or more welders, are recruited "from the country" over

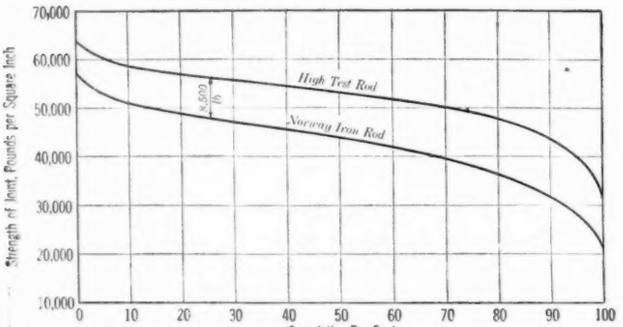


Fig. 5—Tests on welders in a commercial organization

which it passes. Men who have done pipe welding, blacksmiths, and intelligent mechanics are hired for training. It takes about three days to prove whether the candidate is teachable and understands "penetration"; that is, melting through to the very bottom of the joint. If not, he is dropped. Otherwise in four or five days more he will be ready for routine work on ordinary butt joints. It should be emphasized that this is for repetitive welding under close supervision; "journeymen" welders must be intelligent mechanics of varied experience.

How to Test the Welder's Ability

In general, every welder should be tested frequently. He should make welds under working conditions and at production speeds in the same metal and equal thickness to his regular work. These welds are cut into strips, and either pulled in a tension machine or simply bent sharp over the edge of an anvil. Bend these pieces so that the stretch comes at the bottom of the vee. If his work is defective, the piece will crack open at a low angle or bend, and the character of the fracture will indicate the deficiency to be guarded against. When he can bend such a piece (with a single vee) square over against the edge of an anvil, he is doing good work. An oxwelder of satisfactory ability can also make a double-vee weld which can be sledged double, as shown in Fig. 4, with only minor checks at the surface.

Data on the general reliability of welders as workmen are also available. During the last five years the work of seventy-five welders employed on railroad work (mostly locomotive repairs) has been systematically verified. Test pieces were made at frequent intervals (mostly single-vee in $\frac{3}{8}$-in. steel plate), the surplus weld metal ground flush and the specimen pulled apart. Welding rods used were of two kinds, iron and high test.

In the diagram, Fig. 5, the highest strength weld in this series is plotted first, at the left, next highest next and so on toward the right. It will be noted that the curves representing the strengths of the welds made by these two rods are nearly parallel. This is a striking indication of the uniformity and reliability of the welding done by these men of ordinary ability in a commercial organization. Furthermore, it will be observed that 71 per cent of the test pieces on the high-test rod are stronger than 50,000 lb. per sq.in. In other words, three-quarters of all the welders tested are able to make stronger joints with high-test rod and the oxyacetylene flame than can be had with double-riveted butt straps in first-quality boiler plate.

This certainly controverts the statement frequently made that most welders are poor workmen. Here are definite figures to prove that most welders, selected with a decent regard to their qualifications and ability, are not only good welders, but are very good welders.

Adequate Shop Tools

Equipment for oxwelding is so simple that it and the necessary auxiliaries are often neglected. Blowpipes, pressure regulators and minor hand tools should certainly be in first-class condition if good work is to be expected. In order to avoid compound stresses in pressure vessels (one of the principles of correct design) bending equipment should also be capable of curving the sheets clear out to the edge.

Under this heading should also be included the necessary though simple, jacks, wedges, rollers and other fixtures required for placing the abutting edges in the proper position and alignment and holding them there until welded.

Supervision and Inspection

Important work like pressure vessels cannot be left to the ordinary welder, unsupervised, even after his ability has been proved. Like all other workmen he would be tempted to slight the job at times, perhaps from fatigue or impatience. It is only good management to have a superintendent who is thoroughly familiar with the problems surrounding the work in hand,

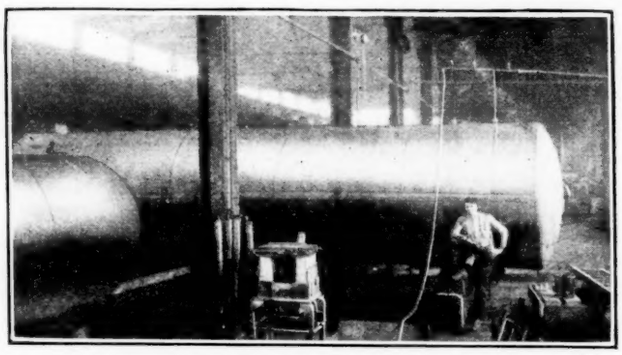


Fig. 6—Propane storage tank under test

and who can tell at a glance whether the flame is melting clear through to the bottom of the joint without overheating the top edges.

However, knowing from periodic tests that the welder can make high-strength welds, and knowing from hourly observations that he is following sound welding technique, then it is possible to rely on the completed joint when it passes final inspection. The inspector looks for uniform appearance. If the weld is regular in height and width, if the temper colors make a band of equal width along the weld, if the weld on the underside shows no places where the inner edges have not been melted together; then the inference is that the good practices observed now and then along the seam are continued without interruption, that the work was not unduly hurried or delayed.

There are several indications by which an inspector can discover poor work, even though he has not observed it in process. A high narrow weld usually indicates lack of penetration. Sometimes the under side of a joint cannot be seen. Laps and cold shuts are easily discovered and are evidence of wholly unacceptable work. A joint that has a little furrow melted into the surface of the plate just alongside the weld should be condemned. Finally, overheated metal shows itself in cavities and blowholes at the top of the weld, at least when high-test rod is used.

Thus while it is doubtless true that an inspector cannot see inside the surface of a weld, any more than he can see inside a steel plate, it does not follow that there are no observable differences between good and poor joints, nor that the unscrupulous and lazy workman can gloss over his work so that it will be passed. Testing the welder and adequate shop supervision eliminate the latter contingency in any type of construction; a uniform appearance is proof that the good workman does not slight his welding between visits of the foreman.

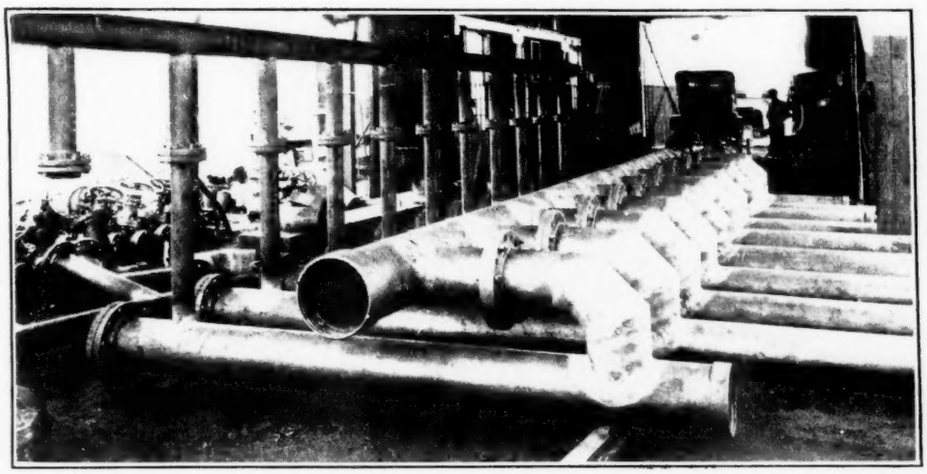


Fig. 7—Specials for oil pumping station, 500 to 750 lb. working pressure

There are definite figures available to prove that the quality of welding and shop performance may be put under control of the foreman. A series of twenty-three pressure vessels 16 in. in diameter by 36 in. long were manufactured to determine this point. Practices were purposely varied, and the lot was divided into four groups, each marked by the maker as being in his judgment either "bad," "poor," "fair," or "good." These tanks were then tested at the United States Bureau of Standards. The average joint efficiency[1] of the four groups follow: Good, 102.7 per cent; fair, 85.4 per cent; poor, 51.2 per cent; bad, 43.1 per cent.

This in the writer's opinion proves that with the other elements of procedure control in operation, adequate shop supervision and final inspection will be able to determine what joints are reliable and what joints are not up to standard.

Oxyacetylene welded joints are of such a nature that they will withstand severe proof testing without harm. In fact, the Bureau of Standards has certified, as a result of extended tests, that "hydrostatic pressure sufficient to produce a permanent set in the shell, enlarging the circumference ½ per cent, apparently does not weaken the tank."

For that reason power-piping codes commonly specify a test at twice the working pressure, hammer each joint vigorously and then increase to three times the working pressure. This is all right for an oxwelded system designed with a factor of safety of six—three times the working pressure would stress the metal to the elastic limit or slightly above, although no harm is done.

Such tests are given large pressure vessels for storage of volatile chemicals and petroleum products. Numbers of oxwelded pressure storage tanks, for instance, have been made 7 ft. in diameter, by 35 ft. long. Shell plate is ⅜-in. firebox steel; the dished heads 1¼ in. thick. Working pressure is 125 lb. per sq.in. Test pressures are 250 lb., all joints hammered while under pressure, and then the pressure raised to 375 lb. No troubles of any sort have been experienced in service; such vessels are becoming standard in the chemical industry because of the impossibility of keeping a riveted vessel permanently tight and leakproof.

Oil transit lines, since the oxwelded joint has made this possible, are designed for much lower factors of safety. A line to work at 750 lb. pressure, therefore, would be tested at perhaps 1,000 lb. In such tests more failures occur in the longitudinal lap-weld (made by machinery in the pipe mill) than in the oxwelded joint. In any event, only one or two would be expected in a hundred miles. Many years' experience with oil lines shows their absolute reliability.

Recent Advances in Condenser Design

The Ingersoll-Rand Co. has recently prepared a pamphlet concerning its surface condenser practice and reporting operating experience with its condensers over a period of several years. Excellent results are claimed under adverse conditions of warm and dirty water and high rates of steam condensation per square foot of surface.

An interesting development is the provision for longitudinal distribution of steam in a surface condenser, through dividing the condenser into sections by making the tube-supporting plates tight, and connecting an independent vapor and air removal nozzle to each of these sections. A different pressure drop is maintained in each section, so as to produce complete penetration of the tube bundle.

Evidence is presented in support of the contention that high water velocities are effective in maintaining the tubes in a better average state of cleanliness than is possible with low velocity flow.

The pamphlet is profusely illustrated and includes a photograph of an actual tube sheet.

[1] Determined by dividing the stress in the shell at failure by the strength of the metal in the shell.

How to Lay Out Power-Plant Piping—II

By SABIN CROCKER
Designing Engineer, Drafting and Surveying Bureau, The Detroit Edison Company

THE first article of this series, in the issue of May 18, discussed the preliminary layout of a piping system, and this second installment shows in a general way how to select pipe sizes. Later articles will deal with materials and dimensions, valves, drips, expansion, hangers, etc.

BEFORE proceeding beyond a preliminary drafting layout of piping systems, it is necessary to determine pipe sizes which allow reasonable velocities and friction losses. The maximum allowable velocity of the fluid in a pipe line is that corresponding to the permissible pressure drop or friction loss from the point of supply to the point of consumption. In allowing for the loss through bends and fittings, it is customary to count each as equivalent to so many feet of straight pipe and take the total drop for the whole line as that corresponding to so many hundred feet of straight pipe. From the standpoint of investment cost it is desirable to keep the velocity as high as practicable without exceeding the maximum allowable velocity or causing excessive operating losses as a result of unduly great friction losses in pipes.

Unwin's formula and charts based on it are widely published and quite generally followed in selecting steam-pipe sizes on a pressure-drop basis, although there are a number of other steam formulas that are used to some extent.

Unwin's formula may be written in the form:

$$p.d. = \frac{0.0001306\, W^2 L \left(1 + \frac{3.6}{d}\right)}{\delta d^5}$$

in which

$p.d.$ = Pressure drop, lb. per sq.in.;
w = Rate of steam flow, lb. per min.;
L = Length of pipe, plus equivalent length for fittings, feet;
d = Diameter of pipe (actual inside diameter), inches;
δ = Average density of steam, lb. per cu.ft.

The average density of the steam is the only item calling for special explanation. For example, if the initial pressure is 100 lb. per sq.in. and the pressure drop is 20 lb. per sq.in., the density should be taken as the average density of steam at 100 and 80 lb. pressure, or approximately as the density at the average pressure, 90 lb. per sq.in. The best way to handle this is to guess at the pressure drop, and take δ for the average pressure for calculation as a first trial. If this does not check the original guess closely, take the calculated value as a second trial, and calculate again. This second trial will usually check close enough, especially for the small drops usually allowed in most practice.

Fig. 1 is an Unwin's Formula Chart plotted to logarithmic scale in order to give a series of straight parallel lines instead of the set of diverging curves obtained on ordinary cross-section paper. While this chart covers pressures up to 150 pounds gage only, it illustrates a convenient way to plot curves of this nature. Friction losses at higher pressures can readily be calculated from the formula and plotted to similar scale for any desired pressure range. There is no formula in such general use for wrought pipe water lines, and if close calculation is required it is well to check up by two or more formulas as given in handbooks, and then be conservative in choosing the result to be used.

In many cases where a pipe line or branch is short, the labor of calculating pressure drop is not warranted. The following table gives reasonable figures for use in such cases, bearing in mind that the lower velocities should be used for small pipes and the upper limits for large ones:

Fluid	Pressure, Lb. per Sq. In. Gage	Use	Reasonable Velocity, Ft. per Minute
Water	25 to 40	City water	120 to 300
Water	50 to 150	General service	300 to 600
Water	150 up	Boiler feed	600
Saturated steam	0 to 15	Heating	4,000 to 6,000
Saturated steam	50 up	Miscellaneous	6,000 to 8,000
Superheated steam	200 up	Large turbine and boiler leads	10,000 to 15,000

Allowable steam velocities in turbine leads are considerably higher than in reciprocating-engine practice, since there is no pulsating inertia factor to consider with turbines. A steam receiver close to the steam chest of reciprocating engines is frequently employed to steady steam flow and damp out pulsations in the line. Such a receiver is not required with turbines, as their consumption of steam is continuous. Another factor affecting permissible steam velocities is erosive action on valve seats and similar exposed parts. Such action is much more pronounced in the case of wet steam than with superheat, and velocities should be correspondingly lower when there is much moisture in steam. A good example of the cutting effect of moisture is evidenced in the greater wear shown on blades in the lower stages of turbines where the steam has expanded below the saturation point, in comparison with the relatively small wear on blades of the higher stages where the steam is superheated.

In connection with the determination of proper pipe sizes it might be well to discuss a few special cases by way of illustration. Steam velocities of 50,000 to 75,000 ft. per min. are sometimes used in steam feeder lines leading from central heating plants to remote distribution centers in the network of service lines which serve the customers. These distributing centers may be a half mile or more from the heating plant and the feeders supplying them lead through tunnels or concrete pipe conduits. The boiler pressure in the heating plant may be from 75 to 150 lb. per sq.in. gage, while the pressure in the distributing network is usually 25 lb. or less. The carrying capacity of a given size feeder is much greater with the denser steam at the higher pressure, and radiation losses are considerably decreased by keeping the feeder size small. No serious thermal

loss is involved in this case through the generation of steam at a considerably higher pressure than that at which it is distributed, since it is heat units rather than heat "head" which the customer desires and pays for. This arrangement of allowing the pressure drop to take place in the pipe itself obviates the necessity for a reducing valve, saving not only the price of this valve, but also eliminating the trouble of its maintenance. Regulation of pressure in the distribution system is made with a manually controlled throttling valve in the boiler plant with reference to a pressure gage electrically connected to the distributing center.

The significance of the case of the feeders is that high velocity is not in itself objectionable. There has been no appreciable erosion of the pipe walls and no other bad effects. The practice of considering them velocities at all is somewhat of a heritage from steam-engine days. However, it is simpler to compute velocities than pressure drops, and there is of course a definite relation between them. A given velocity, however, produces a higher pressure drop in a small pipe than in a larger one, a fact that should not be overlooked. Noise is seldom a factor to be considered in power-plant piping, although it is in building heating systems.

Another special case is the method used in removing superheat from the steam used to drive a small reciprocating pump which circulates oil to the bearings of a small turbine unit in a large central station. The steam cylinder of this pump, which was of cast iron, would not stand up under superheated steam at 700 deg. F., which was available to operate it, neither did it require the full pressure of 400 lb. gage. The expedient adopted was to take its supply from a rather remote point through a small pipe that was left bare. The long run of small bare pipe served to remove the superheat and at the same time reduce the pressure at the steam cylinder. The loss of available energy was negligible in comparison with the convenience of this simple arrangement.

In general, the selection of pipe sizes is a matter for careful calculation modified by experience and common sense. In a plant of any size it is obviously desirable to avoid the use of numerous sizes of pipe, since the stock of tools and of spare pipe, valves and fittings can be materially reduced if only a few sizes are used. It is often cheaper to use a larger pipe than to use an odd size. On the other hand, where space is at a premium, it may be necessary to use a smaller size than would otherwise be good practice. The calculation of velocity or pressure drop is a valuable check, but in the last analysis judgment is the final deciding factor, and general rules are impossible.

Chart for solution of Unwin's formula

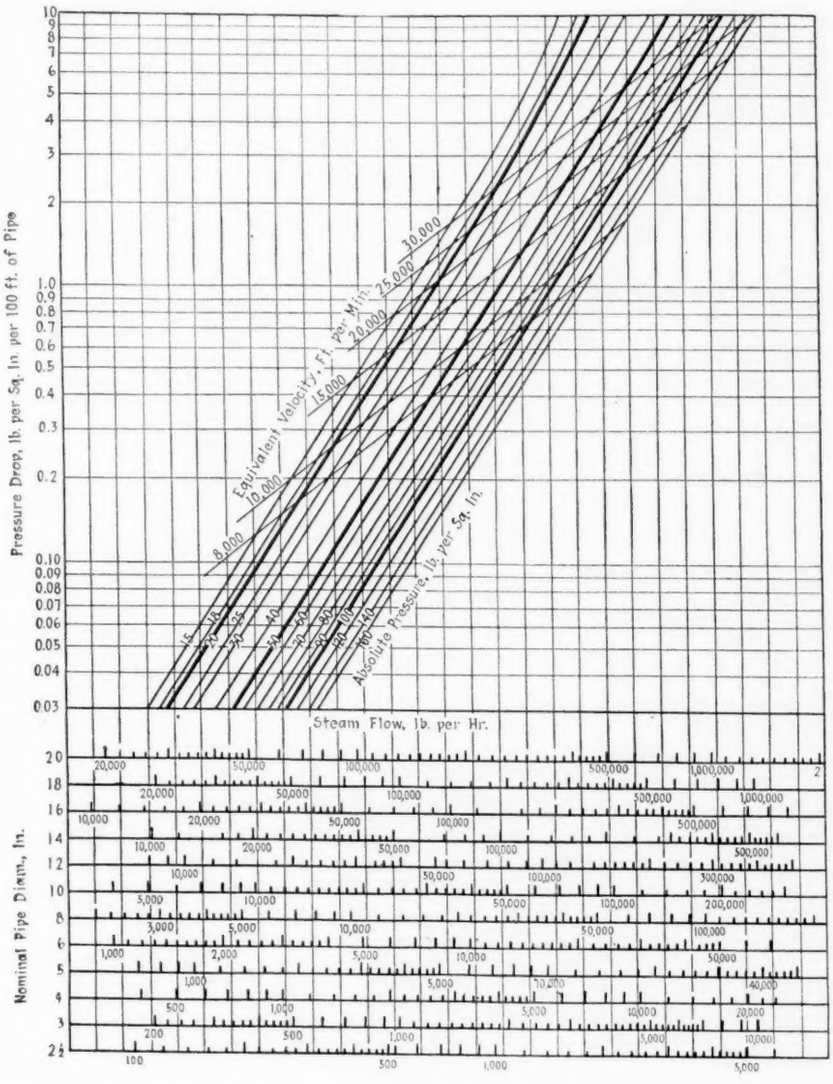
$$p.d. = \frac{0.0001306\ W^2 L \left(1 + \frac{3.6}{d}\right)}{\delta d^5}$$

To obtain the actual steam velocity, multiply the equivalent velocity found on the chart by the factor corresponding to the pipe diamenter.

Nominal Pipe Diameter, in.	Factor
2½	0.3667
3	0.4336
4	0.5344
5	0.6277
6	0.7102
8	0.8633
10	1.000
12	1.116
14	1.189
16	1.298
18	1.390
20	1.465

The following pipe sizes were used in calculating and laying out the chart:

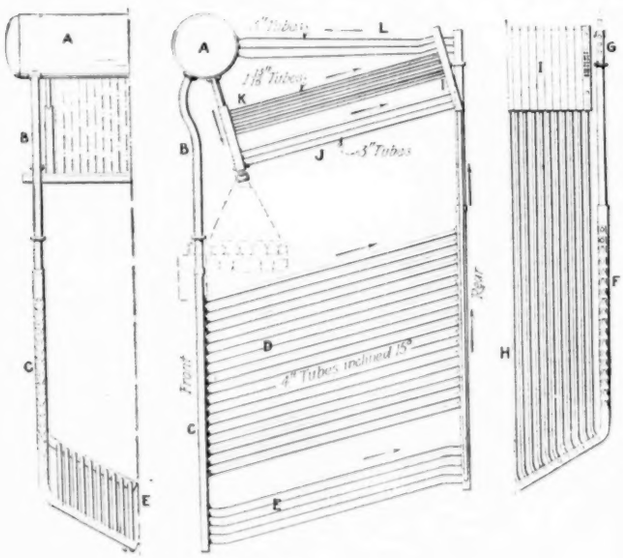
Nominal Diameter, in.	Actual Inside Diameter, in.
2½	2.47
3	3.07
4	4.026
5	5.047
6	6.065
8	8.071
10	10.136
12	12.09
14	13.375
16	15.250
18	17.250
20	19.125



New Type of Watercooled Furnace for Pulverized Fuel

By C. Voetsch*

Some time ago the former Vickers-Spearing Boiler Co., London, England, developed a pulverized-coal furnace of great advantages and simplicity. Such a boiler was purchased in England by the Stinnes concern to be installed near Hamburg, and was to be thoroughly tested with the view of using it for marine purposes, but the actual installation was arrested by the sudden liquidation of this concern. While the boiler itself rests somewhere in England and the tubes in Germany, the design of the boiler house with which the writer was entrusted as representative of the Vickers-Spearing



Vickers-Spearing pulverized-coal boiler

Co., is still on paper. It was a rather delicate task to fit the boiler of English design to the strict regulations of the German boiler code.

High temperatures, up to 2,900 deg. F., may occur, depending on size of furnace, the material and its fineness, and may be of advantage. However, special attention with reference to the refractories is required, and it was therefore decided to use the English refractories, on account of being more promising with reference to their fire-resisting quality.

Another step in resistance of the effects of the high temperature is the cooling of the furnace walls. This is accomplished by means of air ducts in the furnace walls, the preheated air then being turned into the combustion chamber, or by means of feed-water leads built into the wall or in front of it, thus protecting the inner wall surface against the intense heat. An enlargement of the furnace may reduce the heat per unit of surface; however, this is undesirable on account of wasting space and, furthermore, with respect to direct refraction, the ratio of effective to the inefficient surface becoming less favorable.

The general features of the boiler to be described here vary in many details from the arrangements generally used. As shown in the illustration, two distinct circulating systems consisting of headers and tubes are evident. From the steam drum *A* the water drops in the two downcomer pipes *B* into square seamless front headers *C*; from these headers two tube systems *D* and *E* lead to the two rear headers. The tubes *D* are built into the side walls, tubes *E* form the customary chilling grate for the granulation of the ashes and slack, reclaiming at the same time some of the heat contained therein. The two rear headers *F* rise up, and each is connected by three return tubes *G* with the drum. From the bottom part of the rear headers a row of tubes *H* run to the section header *I* of the actual boilers and are built into the rear wall. The actual boiler or main steam-producing system consists of tubes *J*, superheater *K* and return tubes *L*. All tubes are accessible through caps in the headers.

The entire boiler is steel-cased and asbestos-lined. The front furnace wall is cooled by air ducts in the usual manner; the air entrances and the oil burners are also located in this wall.

The boiler is designed for 315 lb. working pressure and 660 deg. total temperature. The total boiler surface is 5,380 sq.ft. The total steam production is 39,672 lb. per hour, of which 7,900 lb. is generated by the cooling system.

Six boilers of this type are installed at Hyderabad and have given satisfactory results; for three years no tubes or refractories had to be replaced.

*Hydraulic and electrical engineer, Utica, N. Y.

Italy Utilizes Peat

Of late years Italy has devoted considerable attention to methods of utilizing the peat deposits that abound in certain parts of the country, for the generation of electrical energy, as the cost of coal is extremely high there owing to the fact that it all has to be imported. A new and important installation of this kind has been established at Torre del Lago, near Lucques, by the Societa Torbiere d'Italia. The peat is treated in Mond-type gas producers, the gas being employed for firing the boilers that supply steam for the turbo-generators.

The peat is obtained from a deposit on the banks of Lake Massaciuccoli, where it is estimated that no less than 12,000,000 tons are available. The water content runs as high as 85 per cent. It is first dried in the open air until the moisture content is reduced to about 35 per cent. The air-dried peat is then loaded into scows and transported to the gasification plant about 1½ miles away.

At present six gas producers are in operation, but two additional sets are being installed. Each of the producers is capable of gasifying three tons of peat per hour under normal conditions and four tons per hour when accelerated to meet the peak-load demands. The gas is piped directly from the scrubbers to the eight Tosi vertical-tube boilers, no gas holder being employed as a measure of economy in installation cost.

The electrical plant in which the gas is utilized will eventually consist of three sets of 5,000-kw. turbo-generators. At present two generating sets are in operation, the output being utilized for traction purposes on the Spezzia-Pisa-Leghorn and Pisa-Florence electric railways. It is estimated that, when completed, the Torre del Lago installation will be able to supply 30,000,000 kw.-hr. and produce byproducts to the extent of 5,000 tons of tar and an equal quantity of sulphate of ammonia per year.

Making Insulation-Resistance Tests

By T. B. WHITSON*

IT IS becoming general practice to make insulation resistance tests periodically as a guide to electrical equipment's conditions and, if weak spots are developing, to repair them before an actual failure occurs. The author explains how these tests are made and the difference between such tests and those made to determine the dielectric strength of the insulation.

THERE seems to be confusion in the minds of some engineers as to the difference between dielectric strength and insulation resistance as applying to electrical apparatus generally, and consequently there is some lack of appreciation as to the value of making insulation-resistance tests. All electrical insulating materials have two fundamental

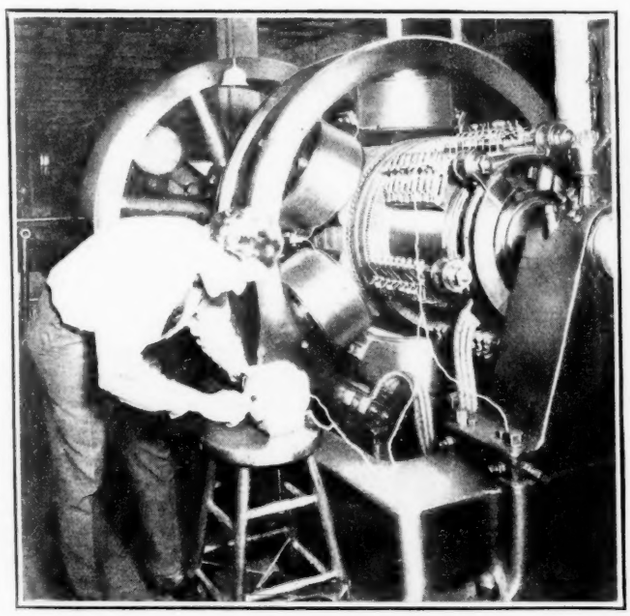


Fig. 1—Measuring insulation resistance of a direct-current generator

electrical properties: (1) Resistance to the passage of current, insulation resistance, and (2) strength against breakdown under static or high-voltage stress, or dielectric strength.

Insulation resistance is expressed in ohms or megohms (millions of ohms) and is proportional to the thickness of a perfectly homogeneous insulating material and is inversely proportional to the area under test. For this reason the insulation resistance of a short piece of wire or cable is higher than that of a longer length, or the insulation resistance of a small machine may be higher than that of a large one. The values can be readily obtained by a number of different methods, one of the simplest of which is to use a megger testing set.

Dielectric strength is expressed in terms of the voltage at which insulation punctures at some point due to static stress, and can be measured only by testing to failure, similar in principle to the way samples of materials are tested to destruction by mechanical stress.

Insulation resistance is not ordinarily a measure of the voltage required to cause an actual breakdown or puncture of the insulation, although frequently such a test is a guide in this respect. A fact which apparently few appreciate is that a piece of electrical apparatus

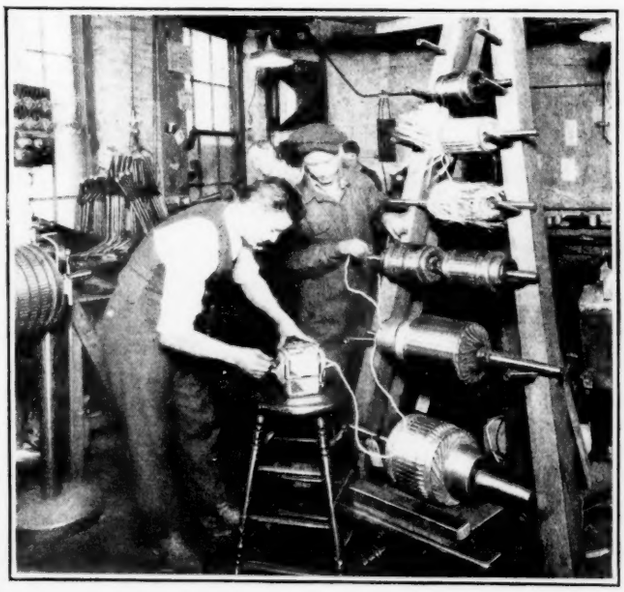


Fig. 2—Testing insulation resistance of armatures in a repair shop

may successfully undergo a rated or specified dielectric strength test and still have relatively low insulation resistance. Low insulation resistance means increased current leakage to ground or to other conductors, and may be due to a number of causes, such as deteriorated insulation, moisture or both and dirty or corroded terminals. There is no way that the high-voltage dielectric test can indicate this condition without breaking down the insulation at some point, and even then it is only known that the insulation was weak at that particular point. Furthermore, high-voltage testing may subject electrical equipment to serious risks of unnecessary and permanent injury, particularly old equipment where the application of high voltage is "playing with fire" as far as trouble is concerned.

The so-called high-potential test is only part of the whole story in testing electrical apparatus, and in many instances it gives only a small part of the information

*With James G. Biddle, Philadelphia, Pa.

one needs to know about the condition of a motor, generator or cable.

It is common practice to apply high potential to new or repaired electrical apparatus. This usually is required by "code" and certainly is important. Experience has shown, however, that much electrical equipment will have a lower insulation resistance after a high-voltage test than before the test is applied, showing that something has happened which in all probability should not have. For example, if the insulation resistance of a repaired 50-hp. induction motor measures 2 megohms, it is liable to measure as low as 1½ megohms or lower after the motor has apparently successfully

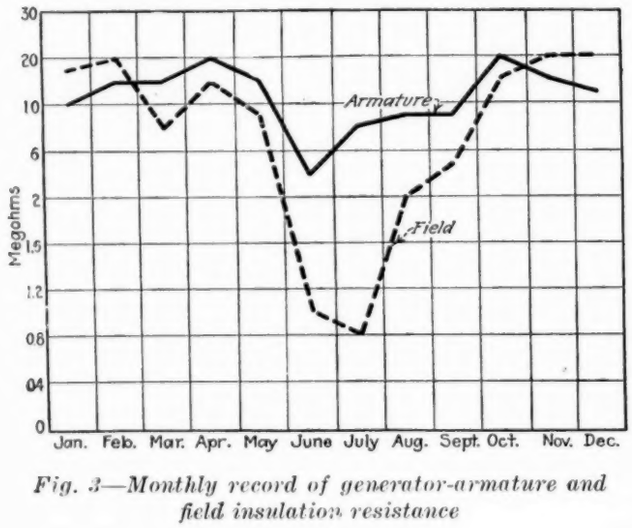


Fig. 3—Monthly record of generator-armature and field insulation resistance

undergone a high-potential test. There is no way in which the high potential will indicate this weakened condition, unless it is carried to the point where the apparatus breaks down entirely.

Applying a high-potential test is somewhat like suddenly dropping four or five times normal load into an elevator, which, if the rope stands the strain, is expected to carry you and a normal load up eight or ten floors. There is no way of knowing whether or not the ropes were strained to the breaking point when the breakdown test was applied. It would have been more in the interest of safety to inspect the elevator ropes carefully for broken strands, and as to how much they stretched during their life, or would stretch under a given load.

There are many electrical men who consider it worth while to make an insulation-resistance test both before and after a high-potential test. Unnecessary breakdown can be largely prevented by this method if a suitable standard is maintained, and to that extent the insulation test is a guide as to the amount of high voltage which it is safe to apply. It should be understood that the high-potential test is not replaced by the insulation-resistance test on new or repaired apparatus. For example, ⅛-in. air space between a misplaced conductor and the frame of a machine may have good insulation resistance, but would readily break down under high voltage. However, such a failure usually is not one of insulation but of workmanship.

One will seldom risk the application of high-voltage to a motor or cable, for example, which apparently is all right, but which needs to be checked as to its condition. Manufacturers do not recommend this practice, and common sense will dictate that the risk is unnecessary. It is here that the insulation-resistance test is of greatest value; it does no harm to the apparatus being tested and it shows on a direct-reading scale what the condition of a motor or generator is relative to deterioration moisture or dirt accumulation which weakens conditions and makes for troubles and interruptions of service. Insulation resistance varies considerably with temperature and humidity, etc., but it takes little practice on the part of an alert electrician to determine the condition of a piece of electrical apparatus, by means of an insulation-resistance test.

Regular tests and records are helpful in this connection. If a 100-hp. motor had 10 megohms insulation resistance a year ago and tests once a month or so have shown a falling off until now the insulation resistance is less than one megohm, this is ample warning that something is going wrong. Your own general acquaintance with that motor should indicate about what and where the trouble is. On the other hand, there may be another 100-hp. motor of the same type which has held consistently around 1 megohm for the last year, possibly up to 1.5 or down to 0.8 megohm, depending on specific conditions when the tests were made; but that machine is all right, even though its insulation resistance is the same now as the first motor, which ought to be up to its own normal of 10 megohms. It is common practice to use 1 megohm as a safe working standard for electrical apparatus, but actually the insulation resistance is relative, the same as a barometer or temperature reading is relative; is it rising or falling?

Monthly Record of Insulation Tests

In Fig. 3 is shown the record of insulation tests made monthly on an alternating-current generator for one year. The plant is in the East at tidewater, therefore the apparatus at times is subjected to considerable moisture in the air. One megohm has been set by this company as the minimum insulation resistance of the stator and field coils. If the insulation resistance is above this, it is considered entirely satisfactory. The field of the generator is tested with the rheostat connected. If the insulation resistance is found to be low, the field winding and rheostat are separated and each is tested separately. The curve for the field winding shows a decided drop in June and July. By testing the field winding alone it was found to be in good condition, the low resistance being due to the asbestos insulation on the rheostat absorbing moisture.

In the hands of an alert, intelligent electrical man an insulation-resistance testing set is a valuable tool, and if intelligently used, the results obtained far outweigh the cost of the testing set and time required in using it. The following are a few typical examples of these tests:

One of the engineers of a chemical company began the practice of insulation testing some eight years ago and found it so valuable that now the company has an instrument for this purpose in each one of eighteen different plants situated in various parts of the country. They require that insulation-resistance tests be made regularly and have had made specially for their

use a combination set with which they test as low as 5 ohms and as high as 5 megohms.

A construction engineering company of Cleveland uses an insulation-testing set on practically all electrical equipment which they install. They state that these tests are made entirely of their own accord, and for their own satisfaction and protection, with the result that they have no misgivings as to the outcome of any tests that the customer may legitimately demand.

Similarly, an engineer of a large Eastern power company informed the writer some time ago that as a result of their practice of making insulation tests on all important generators, transformers, etc., when installed or repaired, and requiring a high reading for acceptance, they practically never have a failure under high-voltage tests which can be traced to faulty insulation.

Many insurance companies that insure electrical apparatus, are depending largely upon the insulation-resistance method for acceptance of electrical risks. Tests are made at regular intervals by testing sets, and a safe standard of insulation resistance on motors, generators, etc., is required.

The practice of making insulation-resistance tests has grown steadily during the last ten to fifteen years, and it would appear that the subject is destined to receive much more general attention and be given wider application. Particularly will this be true on account of increasing necessity for uninterrupted service while plants are in operation, and the further economic advantage of preventing unnecessary trouble.

Lubrication of the Mechanical Stoker

By Allen F. Brewer*

ALTHOUGH continuous operation of a power plant depends upon the proper functioning of the stoker, little attention is given to the lubrication of the stoker driving units. Broadly speaking, we are concerned with the oiling of the worm and spur gearing used for speed-reduction purposes; the bearings of electric motors, turbines, steam engines, and of such shafting as is involved in the operation of movable grates; and steam cylinders where steam engines are used as the driving units.

Gear Lubrication

Perhaps the most important operating parts from a lubricating point of view are the worm gears. The relatively low speed of the average stoker requires large speed reductions, especially where electric motors or steam turbines serve as the driving units. Location of the worm below its companion gear is regarded as being conducive to better lubrication, due to the greater area of tooth surface that the worm affords in the transmission of lubricant from the oil bath below. In such installations an oil level carried at about the center-line of the worm will afford ample submergence and lubrication of both worm and gear teeth, provided the lubricant is of sufficient viscosity and adhesiveness to be transmitted to and retained by the tooth surfaces during meshing.

*Texas Company.

The fact that this lubricant must frequently serve to lubricate both gears and bearings necessitates consideration of the requirements of each. In general, from a viscosity point of view, there will be a fairly wide variation. Bearings, for instance, will function with the least amount of fluid friction if a comparatively light engine oil is used. Gearing, on the other hand, requires body or viscosity to insure the maintenance of a lubricating film which will effectively resist the relatively high pressures that occur between the teeth. To meet these more or less opposing requirements, it has been found that lubricants of the nature and viscosity of medium-bodied steam cylinder oils with a viscosity at 210 deg. F. of from 100 to 120 deg. Saybolt, function best.

Bath Lubrication Best

Bath lubrication is of course best, for it enables the more economical and cleanly usage of oils that will be light enough to give the requisite bearing lubrication without development of abnormal heat due to internal or fluid friction. The use of open gearing or non-oiltight housings requires heavier lubricants, to resist dripping and the throwing-off effects of centrifugal force. Under such conditions bearings should be independently lubricated by means of grease, or oil applied by oil cups, etc.

Where the worm is located above the main gear, as is found in certain installations, there will be less tooth area available to carry the lubricant from the bath to the teeth as they pass into mesh. As a result it will be advisable to use a somewhat heavier lubricant, say, a straight mineral steam cylinder oil of from 140 to 160 seconds Saybolt viscosity. It will also be advisable to carry the oil level somewhat higher, submerging perhaps from three to six of the lower teeth completely, in order to insure the retention of enough lubricant to lubricate the worm above and resist the effects of wiping and tooth pressure.

Where spur-gear reduction drives are involved, it will frequently be possible to use a somewhat more fluid lubricant for the worm gears, provided of course that housings are built oiltight. Unless tooth pressures are relatively high, as in the main gears of such devices, it will be possible to use a relatively fluid mineral oil of from 700 to 800 seconds Saybolt viscosity at 100 deg. F. A heavy grade of machine or motor oil would serve this purpose very well.

In view of the fact that certain stoker gears may be exposed or but improperly housed, it will be advisable to use a heavier lubricant than those mentioned, regardless of the types of gears involved. To an extent this will, of course, tend to increase power consumption and "drag" due to the increase in molecular or fluid friction within the lubricant. On the other hand, gear lubricants of approximately 1,000 seconds Saybolt viscosity at 210 deg. F., which would usually be recommended for such service, are high in adhesive ability, resistant to heat, and economical by reason of the small amount necessary to lubricate. They can be effectively applied by means of a brush. Heating slightly will facilitate spreading of an even film on the teeth. Heavier gear lubricants have a decided affinity for dust or any foreign non-lubricating matter that may come in contact with them. The proximity of stoker drives to coal hoppers is therefore a potential lubricating

problem, for a certain amount of coal dust will practically always be present to contaminate gear and bearing lubricants.

Stoker Bearings

Lubrication of stoker bearings is chiefly confined to those that are located outside of the furnace proper. Such bearings as are within are seldom lubricated, or even designed for this. Their clearances are high and the motion is generally slow, although temperatures are relatively high.

In the case of external bearings, such as the front and rear shaft bearings of certain chain-grate stokers, careful attention must be given to lubrication. To counteract the possibility of entry of dust or other abrasive foreign matter, provision for grease lubrication is made by many builders and preferred by many operators.

Grease is admirable as a lubricant under conditions of higher temperatures and in the presence of dust or dirt, provided a grease of sufficiently high melting point is used. The latter will be an insurance that the grease will not become so fluid as to run prematurely through the bearings and drip from exposed ends to result in waste and sloppiness.

Selection of the Proper Grease

The selection of a grease should be made only after due consideration of the particular operating temperatures, pressures and dust conditions. It is not advisable to atttempt to lay down any standard specifications, but rather, to urge more careful study of the controlling factors. Compression grease cups, pin-type cups and pressure guns are all used with grease. The first two require a grease of lighter consistency than the pressure gun, the reason being that temperature must be more or less depended upon to enable flow, or forcing of the grease to the journal and bearing. The pressure gun, being capable of developing pressures of 1,000 to 2,000 lb. per sq.in., can handle heavier lubricants, and especially those of higher melting points which must be forced into direct contact with the journals and into the clearance spaces.

With the grease gun all that is necessary is to continue forcing in the lubricant until an efflux of new grease appears at the bearing ends. This is a sign that the clearance space has been freed of old, and perhaps deteriorated grease, dust, dirt and gummy matter, and that their place has been taken by fresh grease.

Splash-Oiling Principle Involved

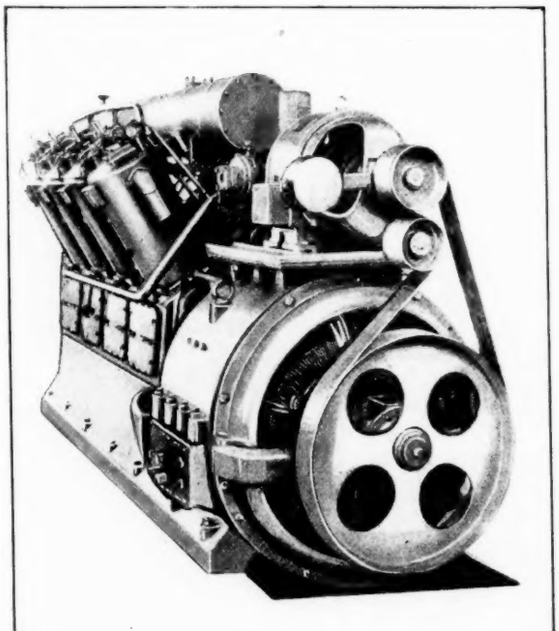
The principle involved in the lubrication of the working parts of a stoker engine is virtually that of splash oiling, the crank disk dipping into the lubricating mixture in the base at each revolution. The word mixture is used inasmuch as oil mixed with water has been found to give satisfactory results in the reduction of friction and wear. In operation the crankcase is kept filled with water to a certain level, controlled by a suitable overflow. On this body of water is floated a layer of from $\frac{1}{8}$ to $\frac{1}{2}$ in. of oil.

To afford most effective lubrication and mix best with water, a specially refined oil of approximately 100 seconds Saybolt viscosity at 210 deg. F. should be used. Where a compounded steam cylinder oil is desired, which would give better emulsification, especially under conditions of fairly wet steam or lower pressures, a cylinder oil of from 130 to 150 seconds Saybolt viscosity, compounded with from 6 to 9 per cent of fixed or fatty oil will be best. Such an oil, however, should not be used for crankcase lubrication, due to the excessive amount of emulsification or lathering that might occur to interfere with effective distribution of the oil.

Lubrication, of course, is not a cure-all for stoker troubles, but under conditions of severe or abnormal operation it is certainly a preventive and a means of prolonging that time when replacement of parts must be undertaken. In view of its relatively low cost it is worthy of every attention by those concerned with the operation of any stoker installation. More positive operation, lower power consumption and decreased maintenance costs constitute the reward.

Sulzer V Diesel for Rail Cars

The Swiss Federal Railways have placed orders for two motor cars for use on the non-electric portion of the Swiss system. One of these will be engined by a 100-hp. gasoline unit, and the second by a 250-hp. four-stroke-cycle, solid-injection Diesel built by Sulzer Bros. This Diesel, shown in the illustration, has eight cylinders, arranged V-fashion in two rows. Each of the four crankpins accommodates the rods of the two adjacent pistons. The engine is without an air compressor, the fuel being injected by direct pump pressure. At 550 r.p.m. the output is 250 brake horsepower.



Sulzer V-type two-stroke-cycle Diesel for rail cars

The direct-current generator is designed to give 750 volts at maximum car speed, and during starting of the car the amperage is to be 325. The exciter, as shown in the illustration, is set above the generator, being belt driven, and is also used as a starting motor, current coming from a storage battery.

Getting the Most Out of Bleeder Turbines

SOME look upon the mere installation of a bleeder turbine as proof of thrift in the use of steam, but there is more to it than that, as pointed out by Walter Slader in the article starting on page 883. In some plants the process load is high and the power load relatively low most of the time. If all the power needed can be generated by straight back-pressure operation ninety per cent of the time, it may be hard to justify the extra cost and complication of a bleeder turbine with its condensing equipment. In this connection one should not overlook the possibility that an increased boiler pressure may throw the balance in favor of the straight back-pressure turbine.

But assume that the back-pressure machine has been definitely ruled out in favor of the bleeder unit. Steam pressure remains an important consideration. Higher pressures offer two possible advantages. One is a reduction in the amount of steam going to the condenser, with a consequent saving in fuel and cost of condensing equipment. The other is the chance for a higher bleeder pressure. If the bleeder pressure is increased from 5 lb. gage to 15 or 20 lb., smaller piping can be used and process operation made more dependable.

Of course it is one thing to start with a new high-pressure plant and quite another to rebuild an old plant for higher pressures. Yet the latter procedure may sometimes be warranted, particularly where the original plant is badly out of date. In a new plant there need be little hesitancy about adopting boiler pressures as high as 300 lb. wherever the heat-power balance calls for it.

Interchange of Power

INTERCHANGE of power between utilities is now well established and has proved advantageous in promoting continuity of service, reduction in reserve capacity, greater diversity of load and operating economies. As between utilities and large industrial plants, however, the practice is to be found only in isolated cases. Many engineers have pointed out the economic advantages of such an interchange of energy, but central-station executives have, for the most part, been only lukewarm to the suggestion. Perhaps it was leadership that was needed. Now that Samuel Insull has come out strongly for the idea, it is possible that greater interest will be shown.

In his address before the National Electric Light Association at Atlantic City, Mr. Insull pointed out that the steel mills in the Chicago district have a combined generating capacity of 300,000 kilowatts and the utility companies are supplying them with only 3,500 kilowatts. He estimated that with proper interchange of power the utilities would supply 100,000 kilowatts and would be able to take from the steel companies about 50,000 kilowatts which is now wasted over week ends in the form of lean gas. He believed the situation an inviting one for study and that the expansion of the electrical, gas, coke and steel industries should proceed hand in hand.

Although Mr. Insull dealt principally with the steel industry, probably because of its importance in the Chicago district, there are numerous other industries that are of equal importance locally and have large surplus of power available. Some of these plants compare favorably in size with the local central stations. It is probable that the economic advantages of power interchange would be worth while only in the case of large industrial plants, but if generally applied in such cases the reduction in fuel and investment in reserve capacity would represent a substantial saving.

Standards a Priori or Standards a Posteriori?

ENGINEERING standardization is endangered by its too zealous friends.

As practice develops, standardization grows in a natural way. Men find themselves doing the same thing in substantially the same way, and it becomes evident that it will be better for everybody if the minor differences can be ironed out through the adoption of standards. A change in the pitch of a screw thread or in the diameter of a pin to line up with a common practice may save the manufacturer a surprising share of cost or widen his market or increase the satisfaction of his customers.

Such gains are true gains for society as a whole—nobody loses. The saving follows from the fact that one kind of screw is made where three were made before. Fewer tools are needed. Time need not be spent in checking tools and product to make sure that the proper one has been chosen.

All such standardization is sound and good, but is not established without difficulty. The need for uniformity develops only through the growth of discordant practices, whose unification demands that someone change his method, and human nature always resists change. However, the benefits are clear, and a compromise is eventually worked out. Usually, no serious basic principles are involved. Such standardization is commonly concerned with dimensions that are to a great extent arbitrary.

But there is another development—a "movement" rather than a growth. The engineering counterpart of the social reformer is occasionally found advocating standardization, and his projects are not always confined to the plain demands of current practice. His ambition is to set up rigid molds for future development, so that the industry of our children grown old shall be beautifully harmonious and free from the divers and divert-

ing elements of today. All this would be well if it could be made certain that the needs of the future are accurately gaged by our present knowledge. But can this be done?

The establishment of standards is a serious business, for it builds up strong prejudice against the special. and may thereby retard the growth of new applications through the inability readily to secure material precisely adapted to the new needs.

Standardization following practice is sane and difficult and valuable. Standardization where no practice exists is foolish and easy and harmful. Industry, like life itself, must grow naturally. Attempts to force it may lead to unexpected ends.

New Surface-Condenser Requirements

THE modern power station, with its large turbines designed for bleeding, has led to some new considerations in the design of surface condensers. All the steam that enters the throttle does not pass through the turbine to the exhaust. Considerable portions of this steam, depending on the number of stages of bleeding, are withdrawn at each bleeder heater. Hence, as there is less steam to be handled in the condenser, the ratio of cooling surface to the kilowatt rating of the turbine has steadily decreased. This lowered ratio is one of the outstanding characteristics of many of the more recently designed stations, where as many as four stages of bleeding are sometimes employed and less than one square foot of cooling surface per kilowatt is provided.

It is necessary, when specifying condenser requirements under such conditions, to give the manufacturer full and complete information on the steam flowing to the condenser at all loads and under bleeding conditions. One should also be able to advise the condenser manufacturer of the heat content of such exhaust steam at the specified vacuum. This heat content will depend on the initial pressure and superheat conditions and the turbine efficiency and also on whether or not reheating is employed. This leads to the conclusion that it is quite proper to specify the heat to be transferred to the cooling water in the condenser, which is the product of the steam flowing into the condenser and the difference between its total heat and the heat of the liquid at condenser vacuum. This heat transfer would form a more logical basis for purchasing condensers rather than by stating pounds of steam only. All the necessary data for such specifications can be secured from a carefully computed heat balance.

Heat-balance considerations impose certain specific requirements on modern condensers aside from that of total tube surface. The pressure drop through the condenser tubes should be reduced to the lowset practicable limits, so that there shall be little difference between air-pump suction and vacuum in the turbine exhaust. This may be achieved by variable tube spacing, by opening up lanes in the tube bank for steam and for air and by other means. All these schemes make the cooling surface more effective for transferring heat.

Finally, there is the question of hotwell temperature. Formerly, this was given little attention. It is now considered desirable to have this condensate heated practically up to the temperature corresponding to the vacuum as heat is conserved and its oxygen content lowered. This temperature may be secured by providing a steam lane around the shell of the condenser to the hotwell itself and permitting the condensate to rain down through this steam into the hotwell. Conditions might be improved in older condensers with a large hotwell depression by providing an external pipe to carry some of the exhaust steam into the hotwell itself.

Heat or Power—Which Is the Byproduct?

ENGINEERS talk of making power cheaply as a byproduct of process or heating steam. It may fairly be asked by what authority the power is called the byproduct thus shoving more of the total cost upon the process steam. Why cannot one with equal justice insist that power is the main product and process steam a byproduct?

To answer this question one must fall back on the common sense of accounting. A system of cost keeping may be called correct when one cannot go wrong by following its indications. If one can demonstrate that consideration of the power as the byproduct leads to money-saving decisions while losses may result from looking upon the process steam as the byproduct, the usual practice will thereby be justified.

Byproduct power will meet this test if one assumption is made. That is that the plant is situated where power can be purchased but heat cannot. This is the usual situation. Under these conditions the cost of producing process steam locally must be incurred in any case. The only choice lies in the matter of making or purchasing power. Now if home-made power is considered as a byproduct and charged only with the *additional* cost above that of simple process-steam generation, it is evident that we have a fair criterion to determine whether power should be purchased or not. Getting power from whichever source appears the cheaper on this basis will be found to give the lowest over-all cost for power plus heat. Thus the assumption that power is a byproduct passes the ultimate business test under the assumed conditions.

But a change in external conditions may make process steam the byproduct. Imagine a city in which a central boiler plant or plants supply steam to all points as freely as gas is ordinarily distributed, but in which no electricity is for sale. In such an environment the factory cost system, to be of any practical value, would have to consider the power as the main product of the power plant and process steam as the byproduct.

Power would necessarily be home-generated. By charging process steam with the additional cost only of producing it, the plant manager would have a true measure by which he could check the advisability of purchasing steam.

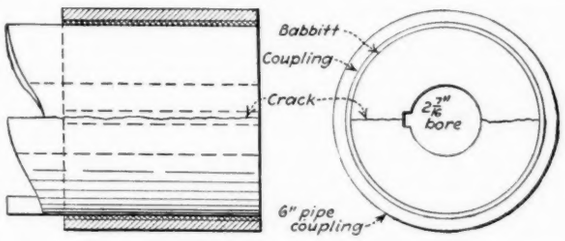
Every point of view or system of accounting must meet this acid test: Is it a safe guide in the search for real dollars-and-cents economy? If so, it needs no other justification. Consideration of power as the byproduct meets this test in the great majority of practical cases.

Since a patent, at best, is nothing more than a club which can be used in protecting an invention, there is a feeling that the applicant for a patent should not be required to battle unnecessarily for the weapon. Internal appeals and other time-consuming procedure within the patent office result in so much delay that an effort is being made to simplify the process.

Practical Ideas From Practical Men

How Clutches Were Repaired with Pipe Coupling and Babbitt

In one of the plants under my supervision we have several clutches on slow-speed line shafting. An employee, through carelessness, threw two of these clutches in, with a heavy load on the machines, cracking them as shown in the illustration. Not wishing any



Pipe coupling was slipped over clutch and space filled with babbitt

delay, I took two 6-in. pipe couplings, which left about ¼ in. clearance, slipped them over the broken halves of the clutches, centered them, and poured the space between the coupling and clutch full of babbitt. These clutches have been running now for four years, giving perfect satisfaction. GUY W. KAY.

Duluth, Minn.

High-Resistance Connections Cause Sparking at Commutator

Recently, I was called to inspect a small motor generator that had developed a bad case of sparking, and the owner was afraid it was burning out. I found several badly burned commutator bars, and the mica burned in two places diametrically opposite on the commutator. Since time was an important element in getting the machine back into service, the apparently open-circuited coil was bridged by soldering across the radials of the commutator. At the first opportunity tests were made for an open-circuit and grounds in the machine However, much as the symptoms seemed to indicate this class of trouble, no such faults were found. The temporary bridges or solder was removed before the tests were made.

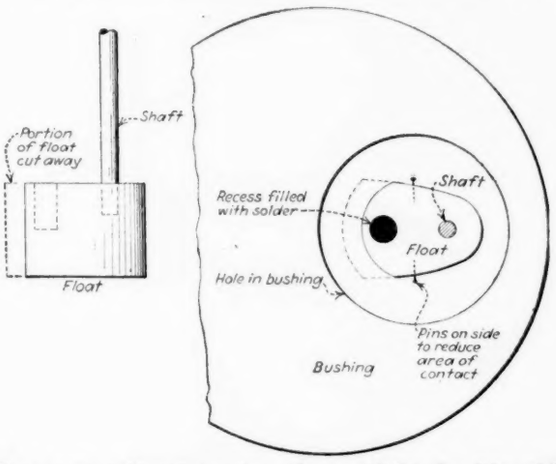
After the tests the radials were examined, which resulted in the discovery of a number of them having high resistance or making poor contact joints with the armature coil leads. Not only were the leads to the burned bars making poor connection, but examination disclosed many others not loose enough to cause sparking. All the suspected radials were cleaned, as well as the ends of the armature wires, as far as could be reached. These ends were then soldered over and onto the radials. After going over all these carefully and cleaning up the work, the machine was started and the commutator was cleaned with No. 00 sandpaper. The brushes were then carefully sandpapered to fit the commutator, and a load put on the machine. After warming up with the load, there were no sparks visible at the commutator, even though the machine was in a very dark place. This was not a hard job and was accomplished without dismantling any part of the machine, and took only a short time. CHARLES A. EHRET.

Kirbyville, Texas.

Troubles of a Mechanical-Type Flow Meter

Some time ago it was found desirable to change the internal mechanism of a flow meter and still retain the same bushing in the base of the meter. It was noticed that the hole in the bushing was not in line with the shaft which carried the float. It so happened that the float was made of a composition that was easy to grind. Since the float was not concentric with the shaft, the first thing we did was to grind away a portion in order that it might work freely in the hole of the bushing without causing too much friction on the sides and thereby bind the shaft.

After the float was ground, it was observed that it was too light to overcome the shaft pulley friction, so to



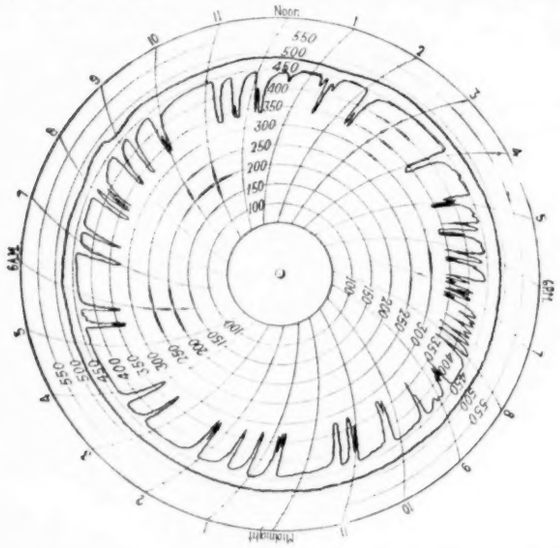
Float was reduced in size, then weighted with solder

obviate this a small hole was drilled in the float and filled with solder to give it the necessary weight. It was then noticed that not enough material had been cut away and the float still insisted to bind. This was eliminated by observing just where the float would first make contact with the walls of the bushing and driving in two short pins, letting them project about $\frac{1}{16}$ in. Since this reduced the area of contact on the walls of the bushing, the float has been operating successfully even though it is not perfectly free to turn around in the hole of the bushing. H. J. BEADLE.

Lynn, Mass.

Moisture in the Steam Affects the Economy of the Plant

While it is generally well understood that moisture in the steam delivered by a boiler to the superheater may be responsible for a lower total temperature and a more varying total temperature delivered by the superheater, this is generally considered by many engineers



Illustrates graphically the effect of moisture in the steam on the final temperature

as being rather theoretical and not particularly affecting the economy of the station.

The inclosed two actual curves superimposed on the same chart so as to show a direct comparison, may be of value in bringing this matter graphically to the attention of many engineers. In order that the curves might not overlap at the outside, the inside curve has been reduced slightly and it should be understood that the inside curve is not actually so many degrees lower on the highest temperature. It is the variation in temperature that I wish to bring out, and its effect.

The inside curve shows the total temperature at the outlet of the superheater on a 1,750-sq.ft. boiler and indicates clearly the erratic variation in the total temperature of steam delivered to the turbines, due to moisture in the steam from the boiler to the superheater. The outside curve shows the total temperature obtained on the same boiler and under the same operating conditions after means had been taken to remove mechanically the moisture and impurities out of the steam before the steam left the boiler drum on its way to the superheater. Certainly, the outside curve shows a desirable total temperature average as delivered by the superheater and is extremely steady and consistent. In other words, the superheater actually functions as a superheater all the time and not as a partial boiler-heating surface to evaporate moisture and part superheating surface.

When it is remembered that at average pressures 1 per cent moisture in the steam to the superheater will lower the temperature of the steam delivered by that superheater approximately 15 to 16 deg. F., and then when it is further remembered that in turbine plants approximately each 10 deg. increase in superheat temperature results in 1 per cent decrease in turbine water rate, the value of maintaining high and consistent average superheat is immediately apparent.

Actual figures at this plant show that the steam, as indicated by the outside curve, was an average of 7 deg. higher than that indicated by the erratic inner curve. It is therefore quite clear that with mechanical means for scrubbing the steam so as to insure delivery of dry steam to the superheater at all times, the result on the station as a whole was an increase in economy of about 0.7 per cent. Looking at this another way, it means that with, roughly 0.7 per cent less total steam to the turbines, the same output was obtained. Certainly an easy way to obtain highly paying results.

Pittsburgh, Pa. R. W. ANDREWS.

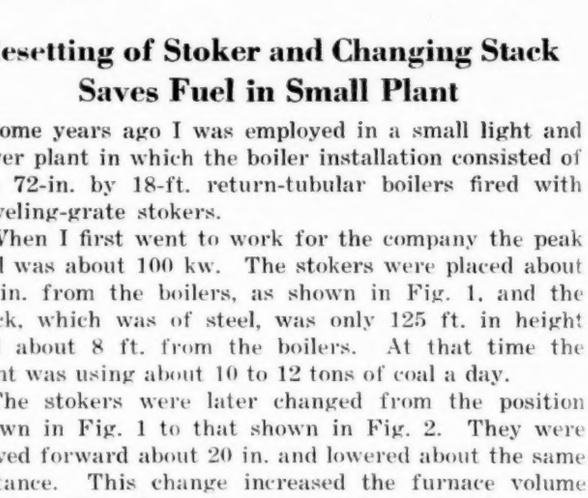
Resetting of Stoker and Changing Stack Saves Fuel in Small Plant

Some years ago I was employed in a small light and power plant in which the boiler installation consisted of two 72-in. by 18-ft. return-tubular boilers fired with traveling-grate stokers.

When I first went to work for the company the peak load was about 100 kw. The stokers were placed about 40 in. from the boilers, as shown in Fig. 1, and the stack, which was of steel, was only 125 ft. in height and about 8 ft. from the boilers. At that time the plant was using about 10 to 12 tons of coal a day.

The stokers were later changed from the position shown in Fig. 1 to that shown in Fig. 2. They were moved forward about 20 in. and lowered about the same distance. This change increased the furnace volume considerably and greatly improved the combustion.

Later a reinforced concrete chimney was built and the steel one, shown in Fig. 3 by dotted lines, was torn



Change made in stoker setting and arrangement of stack

down. The concrete chimney was 150 ft. high and about 30 ft. from the boilers.

The cost of the new chimney was about $5,000, and the saving for the power company for the year following the change in the chimney was approximately $3,500. Some time after these changes were made, the peak load increased to about 200 kw., the average load also increasing, yet the plant only used around 12 tons of coal a day. D. GRIM.

Kansas City, Mo.

Comments from Readers

Power-Plant Engineer's Wages

The Foreword in the March 23 issue, on "Power-Plant Engineer's Wages," referred to the notice of a civil-service examination for an engineer to take charge of a steam-electric plant with all auxiliaries, at a salary of $125 a month.

It might be of interest to readers to know that the highly technical and responsible task of bringing the letters and magazines from the post office and throwing them on my front porch is performed by a rather likeable young colored boy in a gray uniform, who informs me that his salary is $175 a month. "Yas, sah, evy month sence we done got that raise!"

This salary is for a 7-hour day, 5½ days a week, one month's vacation and one month sick leave with pay, and of course the usual legal holidays.

Los Angeles, Calif. WILLIAM QUELCH.

Causes of Turbine Vibration

In a letter in the March 30 issue, F. B. Wheaton attributes turbine vibration to a slightly bowed shaft, due to uneven expansion. With this I can hardly agree. The torsional stress on a turbine shaft, in my opinion, is one of the chief causes of vibration. Insufficient warming up when starting and out of balance are of course common causes. A turbine should be well warmed up before starting, and the higher the vacuum the better.

During the war, while I was on H.M.S. *Warspite* (battleship), I noticed a great vibration of the turbines when going at near full, and full speeds (26 knots), especially when the ship was turning, and the greater the turn the greater the vibration. This vibration I attributed to the torsional stress on the shafts. For the side of the ship making the greater turn rose slightly out of the water, giving the ship a slight list, and therefore the propellers on this side would have a greater slip, causing the turbine to speed up and cause vibration. And on the other side the propellers would draw more water and consequently slow down slightly, throwing a greater torsional stress throughout the shaft and causing the turbines on that side to vibrate. The ship was a quadruple-screw, and the turbines developed around 50,000 hp.

Where I am at present we have one 1,000-kw. and two 5,000-kw. turbo-generators with speeds of 3,600 r.p.m. each. All three are for stand-by purposes. The 1,000-kw. machine is kept ready for bringing up to speed, in about three minutes, it being kept warm at all times. The two 5,000-kw. turbines are brought to speed in about 30 minutes. The 1,000-kw. turbine has been run to full speed in one minute, during which it has vibrated slightly, but not sufficiently to cause alarm or do any harm.

The two 5,000-kw. machines have been run to full speed in 22½ minutes. Both machines vibrated up to the time of leaving the critical speed, about 2,800 r.p.m., after which they settled down to smooth running.

The vibrations I believe were due to the reasons already stated; all three turbines were properly warmed up, with a high vacuum before starting.

It is my opinion that any turbine will vibrate if it is not properly warmed up before starting and given a reasonable time to reach full speed. It is also good practice to have as high a vacuum as possible before starting. All these things, when adopted, help to eliminate vibration. W. J. LOWE.

Winnipeg, Canada.

Privately vs. Publicly Owned Utilities

The controversy over the relative merits of privately owned and publicly owned utilities has continued and probably will continue for a long time; so much has been said on both sides that it would seem unnecessary to add to the mass of literature on the subject. Nevertheless, I cannot resist the temptation to comment on the interview with Governor Smith of the State of New York on the proposed Power Authority, as recorded in the issue of March 23.

What appears to me to be the most conspicuous point made in the interview is the possible savings to the ultimate consumer due to the lower fixed charges on the publicly owned hydro development, owing to the lower interest rate on the tax-exempt securities of the Power Authority as against those of a private corporation. This statement surely implies one of two things—first, that the tax revenue to the state would be reduced, necessitating economies on the part of the government, or second, increased taxes on other articles to make up the loss in revenue, in which case the ultimate consumer would gain nothing. The first alternative is highly desirable, but surely economies in government may be practiced—theoretically at least—without encumbering the state with the management of a large utility.

A second point made is that the Power Authority would be a corporation in fact, and not subject to the whims of politicians, therefore the disadvantages commonly attributed to "municipal" plants would be eliminated. Let us analyze this statement by taking an example and applying it to both types of corporations. Assume that you are a large stockholder in a privately owned utility. A friend approaches you and asks you to help him get a position, say, as operating engineer in the power plant. Your first instinct is to ask yourself whether this friend is suitable for the job. Why? The operating engineer has some influence on the continuous and economical operation of the plant, and on those two factors depend to some extent the continuance of satisfactory dividends on the stock you own. It is perfectly true that you, as a large stockholder, would probably have sufficient influence to gain at least some attention for your friend in his quest for a position. The point is that you would hardly be enthusiastic in pushing a man unless you felt he had some merit.

Assume, on the other hand, that you are a member of the Legislature in a state that operates an electric

light and power plant. A man—possibly a friend, possibly a stranger—approaches you and asks your help to get him a position in the plant. He represents himself as a voter in the district from which you were elected and points out that you are under obligation to him on that account. In these days when political officeholders are elected by organized groups who form a small percentage of the potential voting strength of communities—when they are elected usually for what the organizations hope they can do for them rather than for any fitness by training to maintain good government—the officeholder must be cautious in refusing favors to his constituents. This statement is not intended as a reflection on the officeholders, but rather on the voters or non-voters in general. So that you as an officeholder are more or less obligated to use your influence on behalf of the applicant regardless of your opinion of his ability. How much does that influence amount to? The board of directors of the state-owned corporation are appointed by the Governor, or if there are no directors or commissioners, the general manager is subject directly to political influence. At any rate, the political officeholder has considerably more influence in the case of a state-owned utility than in one that is only state-regulated and privately owned.

All this originates in the fact that as a rule stockholders take more interest in the management of their corporations than do citizens in their public enterprises. Until such time as this condition is changed for the better, privately owned companies as a class will be better operated than municipal plants.

Detroit, Mich. JULIAN HARVEY.

The "Therm" as a Unit of Boiler Capacity

Few who deal extensively in technical terminology and calculation will fail to agree that that incubus of the past, the "boiler horsepower" as a measure of boiler capacity, is—or at least should be—as extinct as those well-known antediluvian twins, the dinosaurus and the diplodoccus. Its continuing recurrence among the misguided can be attributed only to the lack of an acceptable substitute.

Many have turned to "square feet of heating surface." To be consistent such persons should rate motor sizes in "square feet of exposed coil" and turbines in "square inches of blade area." As a measure of capacity such terms tell just enough of the story to be confusing. Radiant heat absorbing surface which "sees" the fire bears as little relation to the convection surfaces of the various passes as the exposed areas of interpoles and of armature coils or the turbine blade areas in the first and last stages. None of these quantities represents more than one of several contributing causes that go to make up a desired result.

Others, more logically inclined, have proposed pounds of steam per hour as a preferable term. There are two principal objections to this: First and least, modern boiler sizes necessitate unduly lengthy strings of zeros, some of which the printer at times may inadvertently omit and which may prove inconvenient in calculation. More particularly, however, the term leads to confusion unless the lengthy and unwieldy "from and at 212 deg." differentiates it from steam "at delivered pressure and temperature."

In England in the gas industry a term has been universally accepted which it is believed would lend itself ideally to the solution of this problem. The American gas industry has recently seized and is accepting it. This term is the "therm," which is equal to one hundred thousand (100,000) B.t.u. The "Therm-hour" (T.H.) therefore would be roughly a little less than three boiler horsepower hours, or about what ten square feet of surface are called on to average at the modern rating of 300 per cent. It is easy to say and to abbreviate. It conveys a distinct idea of heat quantity. It is a unit which in boiler practice can be expressed in three or four figures. Its extensive use in the gas industry to date has so far failed to reveal faults of lexicography.

It may be contended that it was the original purpose of the committee of the British Association of Sciences who first proposed the term in 1896, that it be used instead of the unwieldy and confusing "gram calorie." Later, others proposed it as a substitute for "kilogram calorie" and still others as 1,000 "calories." In spite of its inclusion in various dictionaries under one or more of these definitions, it is believed that those familiar with the present-day literature of the gas industry will agree that the universally accepted significance of the term today indicates one thing and one thing only, namely, 100,000 B.t.u.

Is there a better term or are there insurmountable practical difficulties confronting the acceptance of this proposed new term? Public use is the sole criterion of a word's existence in technical parlance. Let us have everyone's views. Let's agree on *something* to rid ourselves of an irritating babel of half-accepted makeshifts.

Fullerton, Penna. H. W. BROOKS.

The Effect of Preheated Air on Combustible in Refuse—A Correction

In looking over the report in *Power* of the A.S.M.E. meeting at Providence,* I notice that part of my discussion was given the wrong interpretation in abstracting it.

What I stated in substance in discussing Mr. Funk's paper on "Preheated Air" was that with the operating conditions and type of equipment employed at Hell Gate Station, it is doubtful if preheated air could account for a saving of more than $\frac{1}{4}$ of 1 per cent due to the possible reduction of combustible in the refuse, because with the present equipment and method of operation at this station, the loss due to combustible in the refuse is almost insignificant.

I further stated that when the economic capacity of a stoker is exceeded and excessive blast pressure is employed, large quantities of coke may be blown off the grate and into the clinker pit, in which instance it is doubtful whether any material improvement could be expected due to the use of preheated air, since under such conditions the combustible has reached a point where the mere elevation of furnace temperature has but slight effect upon it. The type of stoker employed, rating, grade of fuel and other factors have an influence on the combustible in the refuse.

In order to reconcile the seeming conflict of the abstracted discussion with the actual facts, this correction is called to your attention, although it is quite generally known that phenomenal efficiencies are obtained at Hell Gate Station in spite of unusually high sustained ratings on boiler and furnace equipment.

New York City. W. E. CALDWELL.

*Power, May 11, 1926, page 730.

Asbestos Better Than Clay in Babbitting

I can confirm Mr. Morgan's statement in the April 27 issue regarding the use of a stiff putty of cylinder oil and pipe covering for sealing bearing ends, etc., in babbitting. This mixture has been used in our plant here for a long time and is replenished as needed by pounding up any scrap asbestos or magnesia pipe covering handy, and working it into a stiff paste with a high-test cylinder oil. As it tends to soften somewhat with the heat of the babbitt, it is necessary to support it a little more carefully than clay, which we do by winding over it with the narrow strips of wool torn from the edge of the paper-making felts.

Another handy scheme in babbitting bearing linings with oil ring spaces, such as split motor bearings, is to lay a piece of square flax packing of the proper size in the groove, as this is easily cut away by the tool in boring out the bearing and the remainder can be pried out with little trouble. Where there are no regular fixtures for babbitting, as in many small shops, and wooden mandrels must be used, a convenient way of holding them is to set the bearing shell upon a drill-press table and feed the spindle down solid on top of the mandrel. H. D. FISHER.

New Haven, Conn.

"Blind Spot" Engineering

The editorial "Blind Spot Engineering" in the April 20 issue, prompts me to describe a power installation made in a local cotton mill within the last two years, which is as glaring an example of a blind spot as can be found anywhere. Two compound condensing Corliss engines were replaced by a 2,500-kw. condensing turbine, the old boilers being retained. Five of them are operated at 160 lb. pressure for power purposes. When I first heard of the proposed installation, I naturally assumed that a bleeder turbine was being installed and asked the operating engineer regarding the amount of steam bled. To my surprise he informed me that the turbine was not designed for steam extraction and that four additional boilers were being operated at 75 lb. pressure to supply process steam, which was reduced at the point of usage to about 15 lb. The coal consumption of the low-pressure boilers was between 20 and 25 tons daily.

A well-known consulting engineer designed this installation, and if any outside engineer had the temerity to suggest to the company that they had overlooked anything he would not get a very cordial reception. The contractors who installed the switchboard did a very elaborate job, putting individual voltmeters and ammeters, recording and indicating wattmeters on every feeder panel, of which there were nearly twenty. The chief engineer refused to accept some of this work and ordered about $3,000 of instruments removed from the board as they only added to the cost and served no useful purpose. The recording wattmeter and load indicator were retained on each feeder panel and the voltmeters and ammeters were taken off.

The greatest error lies in the steam end of the plant, where a turbine exhausts 37,000 lb. of steam per hour to a condenser and about 30,000 lb. of process steam is used per hour. The old engines are still in the plant and the defects in the installation can be partly corrected at slight expense. By belting one of the old engines to an alternator, 700 kw. could be generated on the process steam, using only the high-pressure cylinder, as the low-pressure cylinder designed for condensing operation is too large for operation against 15 lb. back pressure. This block of power would be secured at an expenditure of 5,000 to 6,000 B.t.u. per kilowatt, whereas the turbine demands around 25,000 B.t.u. for the same quantity of power. It is generally considered that efficient installations cost more to install, but in this case the first cost could actually have been reduced if this plan had been incorporated in the design, since the turbine could be reduced from 2,500 to 1,800 kw. with corresponding reductions in the size of the condenser equipment.

Brightwood, Mass. A. F. SHEEHAN.

Breaking Into the Game

The several articles entitled "Engineering and the Man," which have appeared recently, prompted me to write of an incident that occurred while I was first watch engineer at a large tobacco plant. The equipment consisted of a Corliss engine with a 350-kw. generator, one piston-valve engine with a 100-kw. generator, four water-tube boilers operating at 135 lb. pressure and the usual auxiliaries.

The middle watch engineer had resigned without notice, leaving the position vacant. The chief called up some friend who had previously furnished him with men, and asked if he knew of a good engineer.

In an hour or so the man arrived with his identification card, and a brand new license.

Seeing me first, he came to me, hat in hand. I referred him to the chief, who interviewed him for about two minutes, hired him and asked him to be back at 1 p.m. for the 1 to 10 watch.

Promptly at 1 p.m. he was on hand, clad in brand new overalls and a new cap, ready to go. He was turned over to me to take around the plant.

His first words were, "Gee, but you have a fine engine there. About how much does it cost?" "Oh," I said, "about $35,000." To my surprise he answered, "Pretty near as much as a street car." I was dumbfounded for a minute, then he confidentially informed me that he had just taken a 90 days leave of absence from street-car service. He said he hoped I would teach him as much as possible about engineering as he wanted to "break into the game."

By this time I knew where we stood. I showed him around the balance of the plant, and each time something new was viewed he used some odd exclamation. When we reached the little 10-kw. machine, which was only used for night lighting, he decided that was just his size and was sure he would be able to handle it.

At 5 p.m. I turned him over to the last watch engineer who had come down early to stay with the new man. He had about the same experience with him as I did, only he wasn't quite so good natured about it. The new man asked him what would happen if the water in the boiler went down out of sight. The engineer told him the boilers would probably blow up. "What do you do then?" he promptly asked. His answer was "You get your hat and coat and go home." Which he did at 10 p.m.

A week later I heard he was back on the street cars. "How do they do it?"

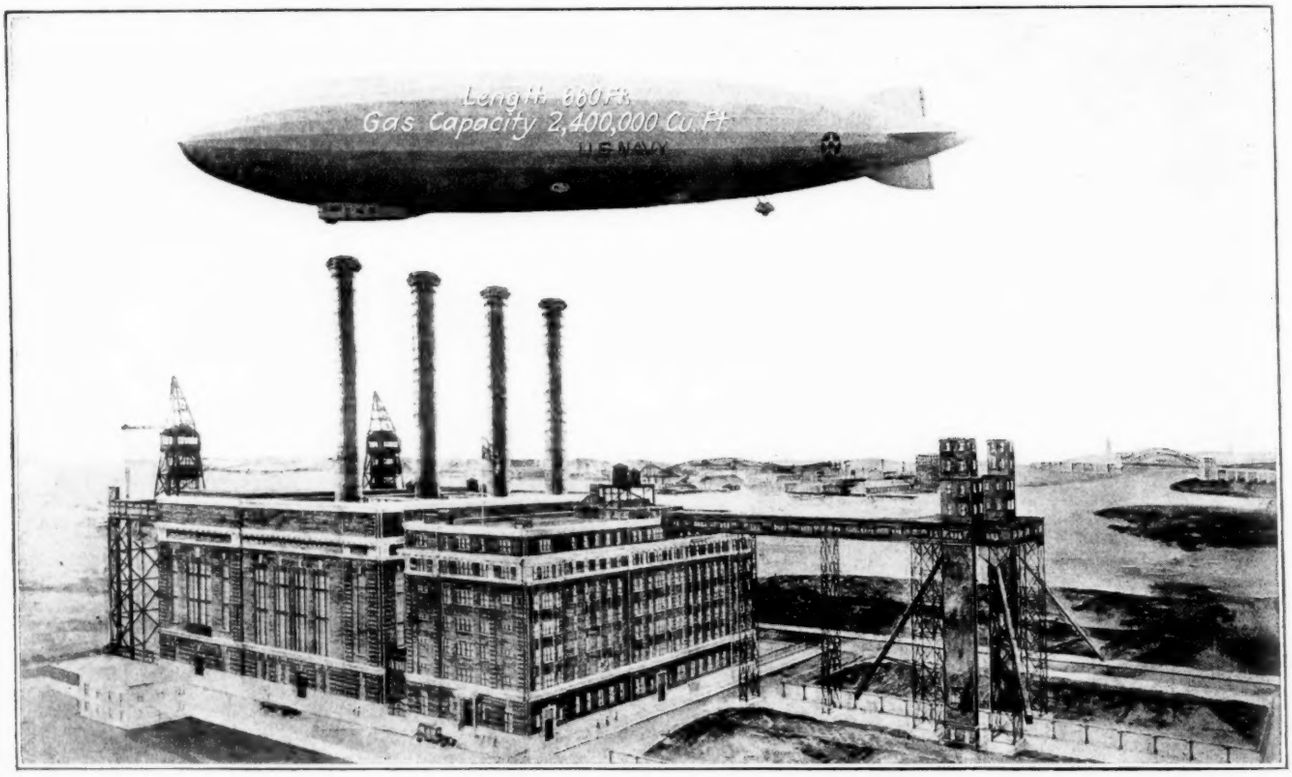
La Grange, Ill. O. S. MARUGG.

A new slant on things observed in and out of the power plant

What Happens and Why?

Flue-Gas Computations Give Startling Results

AS POINTED out in the article "Flue Gas Volume Dwarfs the Coal Pile," on page 828 of the May 25 issue, coal by no means represents the greatest volume or even the greatest weight among the materials handled in the process of power generation. In weight the condenser circulating water produced will occupy all the way from about 50,000 cu.ft. if measured as it leaves the boiler to 10,000,000 cu.ft. as it enters the condenser. The flue gas will run about 400,000 cu.ft. measured cold and about 800,000 cu.ft. if one takes the actual volume of hot gases leaving the stack. On a volume basis the circulating water is about 20,000 cu.ft. or but one-fortieth of the volume of gases leaving the stack.



The hot gases pouring from the stacks of the Hell Gate Station at full load would inflate the "Los Angeles" in 72 seconds
"Los Angeles" photo by International Newsreel

is an easy first, from 400 to 800 tons of circulating water being handled for each ton of coal. Second place on the weight basis is taken by the flue gas or air supplied and third place by the feed water or steam.

On the average, in efficient plants, about fifteen tons of flue gas and about ten tons of steam or feed water are handled for each ton of coal burned. Take as a basis for computation the following comparative figures: Coal, 1 ton; steam, 10 tons; flue gas, 15 tons; circulating water, 600 tons. Air and feed water may be omitted as being practically repetitions of flue gas and steam respectively.

On a volume basis the relative proportions are quite different. A ton of coal occupies about 40 cu.ft. The steam

So, leaving out of consideration the steam entering the condenser (whose volume runs up into astronomical figures and will be the subject of a separate article), the biggest bulk handled is that of the flue gas. The 800,000 cu.ft. of hot flue gas from a single ton of coal would fill a spherical balloon 115 ft. in diameter.

The Hell Gate Station, which, because of its size, has so frequently been used for purposes of comparison, may serve that end here. The present installed capacity of Hell Gate is 285,000 kw. The average coal consumption per kilowatt-hour is around 1.2 lb. and the average ratio of flue gas to coal by weight about 14 to 1. On this basis the full-load coal consumption would be about 340,000 lb. per hour and the corresponding weight of flue gas about 80,000 lb. *per minute*. Taking the volume of the hot stack gases as 25 cu.ft. per pound, the total volume discharged from the stacks per minute would be 2,000,000 cu.ft.

Without taking the trouble to ask permission of the U. S. Navy, the artist has taken the huge dirigible "Los Angeles" from her hangar at Lakehurst, N. J., and suspended her directly above the stacks of the Hell Gate Station. Air ship and power station are shown to the same scale.

This leviathan of the air, the largest in the world, is 660 ft. long and has a gas capacity of 2,400,000 cu.ft. To fill her once with helium costs a small fortune. It is unfortunate that flue gas will not serve as well, for the gases poured from the stacks of Hell Gate at full load would inflate her in the short space of 72 seconds!

The flue gases from twenty-four hours of full-load operation would fill 1,200 such ships. Placed end to end, they would reach 150 miles. In a year of continuous full-load operation the gases would fill a necklace of 438,000 such ships encircling the globe more than twice at the equator.

Operation of Hydro-Electric and Steam Plants in Parallel*

Problems Encountered in the Operation of an Interconnected System of Steam and Hydro-Electric Plants and How These Plants Are Operated to Obtain the Highest Efficiency

By Frank G. Boyce†

THE combination of steam and hydro-electric plants in one system allows the most effective use of the kilowatt-hour capacity of the hydro-electric plants and at the same time allows the operation of steam generating plants at their most efficient loads. A greater number of hydro-electric units can be operated during heavy-load periods, permitting the elevation of the storage reservoirs to be lowered slightly. During low-load periods a greater percentage of the system load can be carried by the steam generating units, allowing the hydro-electric reservoirs to return to their normal elevation so that the hydro-electric generating plants are ready to repeat this cycle of operation at the return of the heavy load.

When a large number of plants are feeding into one network, all hydro-electric units can be operated at the most efficient gate openings at all times, thus obtaining the maximum kilowatt-hour output from the available water; likewise steam generating units can be operated at their most efficient loads. Changes in the system load can be taken care of by starting up or shutting down units.

Testing to Determine Most Efficient Load

Tests can be made which will determine the most efficient load at which boiler units will operate, and as the system load requires, additional boilers can be fired or banked or additional steam turbine units can be brought into service.

The efficiencies of steam generating plants are greatly increased by operation in conjunction with hydro-electric plants, because although the hydro-storage reservoirs may be small, yet the great flexibility of hydro-electric plants, due to storage-reservoir capacities, permits the changing of loads on steam generating plants in blocks according to the most efficient load that can be carried on boiler and turbine units then in operation. The extent to which this can be carried out will be realized when it is pointed out that on a system having 10 steam generating plants ranging in capacity from 400 to 40,000 kw. (some of these plants being rather old ones) a system of fuel economy for one year of approximately 21,000 B.t.u. was obtained, while if these plants were operated as isolated ones, the B.t.u. per kilowatt-hour would have been considerably higher.

It is also possible to obtain a greater kilowatt-hour output from hydro-electric plants operating as a part of one of these systems. As an example, one hydro-electric plant that has been operating for a number of years as part of an isolated system at a yearly output of 2,036,600 kw.-hr., was recently made a part of a combined system and the output was increased to 2,797,900 kw.-hr. per year.

It has been found that the efficiency of both hydro-electric generating plants and steam generating plants can be improved by dampening the governing mechanisms so that all the plants will operate as base-load plants except with such capacity as is necessary to maintain system regulation. The governors on the hydro-electric units will be so set that they will be operating at the most efficient gate opening, and at the same time governors on the steam generating units will be so arranged that they will be operating at their most efficient loads. This is made more certain on the steam generating units by the installation of what might be called a load-limiting device. This device prevents the governor valve from opening beyond a certain amount, preventing the unit from carrying more than a predetermined amount of the system load. This does not in any way endanger the operation of the unit, for if the unit should be suddenly relieved of its load or should speed up for any other reason, the governor would function normally. This device can be so set that any predetermined amount of load will be carried by the unit, which amount can be changed very quickly by the operator. The hydro-electric units can be equipped with "load-limiting devices" similar to those mentioned.

Simplicity of Design

The mechanical and electrical design of these plants can be much more simple than isolated plants. The electric equipment will usually consist of one bank of step-up transformers with its high-tension and low-tension circuit breakers. It will also contain one set of low-tension busbars with an oil circuit breaker for each generator and one bank of transformers to supply power for station auxiliaries.

In some cases it is feasible to omit the low-tension busbars and oil circuit breakers, installing a transformer bank for each generator with oil circuit breakers on the high-tension side of the transformers. These plants require very modest expenditures for buildings, as in most cases the transformers and in some cases the busbars and oil circuit breakers are installed outdoors.

The mechanical design is simplified by the elimination of many of the otherwise necessary duplicate station auxiliaries. The auxiliaries can in most cases be electrically driven, obtaining their supply of power from the main busbars. If in an extreme case the auxiliaries should fail, a momentary interruption to the plant would probably result, but would perhaps be unimportant, as the system load would be carried by reserve in the other plants until the plant that is in trouble is returned to service.

One item of great importance in the mechanical design of hydro-electric plants is the facilities for spilling water should the plant be suddenly relieved of its entire load. This is especially important in low-head plants where the storage capacity of the reservoirs is limited. Plants designed for interconnection are often connected to transmission systems by one bank of transformers or a single transmission line and do not supply a local power load, in which case an interruption to either of these removes all load from the plant. Arrangements must be made immediately to take care of stream flow.

One of the early methods used consists of a Tainter gate arranged to be raised by an electrically driven winch, operated by means of a crank in case of total interruption to power supply. This device was fairly satisfactory although in northern climates it was found necessary to keep the gate free of ice, an operation requiring considerable manual labor. This type of gate was later improved upon by totally inclosing and installing steam coils inside the housing; thus, the gate could be held at a temperature that would keep it free from ice. This requires considerable fuel to maintain proper temperature.

There are a number of other methods in use, including the different types of conduit spillways in which the amount of water spilled is controlled by means of gate valves, butterfly valves or Broome gates. These methods are successful and have some advantages over the Tainter gates, aside from overcoming the ice problem.

Station Records Should Be Maintained

In order to constantly improve the operation of generating plants and to increase the output of hydro-electric plants, an adequate system of station records must be maintained. Each station should be supplied with logbooks in which are recorded all operations which are carried out, also information relative to conditions leading up to each operation. Where operations are performed under instructions from foremen or supervisors, a notation should be made indicating from whom these instructions are received. These logbooks are useful in making studies of past operations and in showing how improvements can be made.

Rain gages should be maintained at each station in order that records of precipitation may be kept. These records are sometimes taken in co-operation with state authorities, in which case they become official government records. These records should be compared with run-off so that probable hydro-electric outputs can be estimated in advance. After heavy rains or in advance of spring floods reservoirs can be so drawn down that the maximum amount of excess river flow will be utilized.

It is necessary that operators of these systems be constantly on the alert to detect any weaknesses which may be developing—thus faults may be discovered before they have interfered with service. In order to accomplish this, an adequate system of inspection and tests must be maintained.

*Abstract of a paper, "Some Interconnected-System Operating Problems," presented before the regional meeting of the American Institute of Electrical Engineers, Madison, Wis., May 6-7, 1926.

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A. I. E. E. Holds Third Annual Regional Meeting at Niagara Falls

New Type of Current Transformer—Protection of Waterwheel Generator Windings Against Fire—Supervisory and Automatic Control of Hydro-Electric Plants

THREE years ago the American Institute of Electrical Engineers adopted the practice of holding regional meetings in the geographical districts. At these meetings papers are presented of a character heretofore given at the national meetings. The sucess of this practice was well demonstrated at the meeting of the Northeastern District held May 26 to 28 at the Niagara Hotel, Niagara Falls, N. Y. This, the third regional meeting held in this district, took on the proportions of a national convention with over 575 members and guests in attendance.

Four technical sessions were held, at which 27 papers were presented. On Thursday evening the convention dinner was held at the hotel, attended by about 400 members and guests. The convention, being held at Niagara Falls, afforded everyone an opportunity to see the many points of interest for which this part of the country is noted and the entertainment committee in its well-thought-out program provided every convenience to take advantage of the time available.

A feature that attracted a great deal of attention was a large model of the Falls, which has been constructed by the Niagara Falls Power Co., on which to try out the various means suggested for preventing erosion of the Canadian Falls and to determine the effects of future water diversion. Daily demonstrations were given on this model, showing the effects of suggested control work to be installed in the river and the proposed increase in water diversion.

New Current Transformer

In a paper entitled "Current Transformers with Nickel-Iron Cores," Thomas Spooner described the characteristics of current transformers having cores made of a recently developed nickel-iron alloy called hypernik, which has especially low hysteresis losses and high permeability at low inductions. Owing to these properties, the material is particularly suitable for the cores of current transformers. A ring-type series transformer with a core of hypernik has approximately one-third the ratio and phase-angle error exhibited by a similar transformer having a core of ordinary silicon steel. This material is much more expensive than silicon steel, but for large installations, where large blocks of power are needed to be measured accurately, the extra cost is insignificant compared with the improved accuracy. The use of hypernik in through-type transformers will, perhaps, be the most important application since it is in this case that the designer finds his chief difficulties in obtaining good performance. In this connection it may be mentioned that hypernik is of no value for cores of through-type transformers operating a heavy burden of relays, since this material saturates at a considerably lower induction than silicon steel. It is only at the lower inductions, namely, for meter loads, that its superiority manifests itself.

Generator Fire Protection

J. Allen Johnson and E. J. Burnham described the fire-protection system used in the three 65,000-kva. generators of the Niagara Falls Power Co. With the usual type of generator construction around the stator end windings, if a fire starts in these windings, the circumferential component of the ventilating air will carry the flame completely around the machine and destroy the whole winding before very much can be done to prevent it. With the new system referred to, the air is directed axially over the windings by a system of baffles, which divide the air space around the end windings into a number of compartments. These baffles prevent the ventilating air from flowing circumferentially and confine it to definite paths through the machine. If a fire occurs in any one of the compartments, it has been shown by tests on large-sized models that the fire would be confined to approximately the width of one compartment for about 15 minutes.

In each one of the compartments, between baffles, is placed a sprinkler head in such a way that it will direct a stream of water on the winding if this becomes necessary. The sprinkler system is normally under air pressure. Should a fire occur in the machine and one head open, the reduction of the air pressure will ring an alarm and call the operator's attention that something is wrong. The operator has a specified program to follow out in the case of an alarm being sounded, such as shutting the machine down, locating the section where the fire is, using hand fire-fighting equipment, etc., before the water is turned on as a last resort. If it does become necessary to turn the water on to the sprinkler heads, the winding is only wet in the sections where the fire actually is.

Mr. Johnson, in presenting his paper, pointed out that methods of protecting steam-turbine-driven alternators were not applicable to waterwheel generators. The former are of closed construction, operating at high speeds and having comparatively small dimensions, where the latter are of open construction, operating at slow speed and consequently have comparatively large dimensions. There has been considerable faith put in differential-relay protection of generators to prevent a fire starting, but the opinion was expressed that there was no reason to believe that a fire could not start from a winding failure in a machine provided with such protection.

Discussion on Fire Protection

In the discussion it was brought out that the use of brakes on a generator, to stop it quickly if a fire occurred, was an important factor in confining the fire to a small area. Brakes for vertical machines are now designed that will bring the rotor to rest in about three minutes. Attention was called to a case where fires had started in a horizontal-type waterwheel generator, due to a break down in the stator end windings, and before the machine could be stopped the fire was carried all the way around the machine, damaging the whole winding. The opinion was expressed that probably brakes would be of some value in the foregoing case, but it was doubtful if they would do any good with the system worked out for the Niagara Falls generators.

Poor winding connections was suggested as one of the chief causes of fires in generators. Defects in these connections are difficult to detect and can easily be overlooked. Failures in the end windings are more likely to cause fires than those in the slot sections of the coils. Operators have a great deal to do with the prevention of fires in generators, and the extent of the damage done, by the attention given to keeping the machine clean.

A system for using CO_2 for extinguishing fires in synchronous condensers was described. In this system, in case of a fire in the machine, the air supply is shut off and the CO_2 turned on automatically. It has been found that about 20 per cent CO_2 in the air will prevent combustion.

Automatic and Supervisory Control

"Automatic and Supervisory Control of Hydro-Electric Generating Stations" was the title of a paper presented by Frank V. Smith, in which he described two systems of supervisory control and called attention to some important applications of the control of automatic hydro-electric plants. An abstract of this paper will appear in a later issue.

In the discussion on this paper the question of reliability in automatic control equipment was stressed. Attention was called to the necessity of the manufacturers' supplying expert service men to put the equipment into operation and get it working properly before turning it over to the owners. If this is not done and the purchaser has a lot of trouble with the equipment, it may cost more to iron out the difficulties than the use of the equipment will save over manual operation in a number of years.

News in the Field of Power

Boiler Inspectors Urge Uniformity for Construction and Inspection Standards

National Board Meets at Chicago to Discuss Reciprocal Agreements Between Code States—New Devices and Problems Considered—Important Papers and Report Read

THE National Board of Boiler and Pressure Vessel Inspectors held its fourth annual meeting from May 24 to 26 at the Sherman Hotel, Chicago. A representative attendance from the various code states and municipalities spent three days in discussing their own specific problems and in listening to a program of excellent papers.

As this body is organized "for the purpose of promoting greater safety to life and property by securing concerted action and maintaining uniformity of requirements in the construction, installation and inspection of steam boilers and other pressure vessels and their appurtenances, and to secure interchangeability between political subdivisions of the United States," the opening discussion centered on practices and code interpretations in the various sections. The inspectors agreed in general on the main power code, but were desirous that certain minor discrepancies between it and that section of the locomotive code referring to stationary practice, and the miniature boiler code, be brought in accord.

Reciprocity Needed

Reciprocal arrangements among the various code states to bring about the general recognition of commissioned inspectors was considered highly advisable. To bring about reciprocity it was recognized that there must be uniformity in the examinations, in the number of questions and preferably in the dates and rules under which the examinations should be conducted. It was suggested that the national board prepare the questions, the state board conduct the examination and that certificates of competency then be issued by the national board which would be recognized in any code state.

To show the growth of the organization, C. O. Myers, secretary-treasurer reported 101 manufacturers registered for stamping boilers as compared to 85 last year and 467 inspectors carrying national board commissions against 391 a year ago. Boilers registered with the national board numbered 12,820 in 1923; in 1924 the number had increased to 13,145, and to 16,170 in 1925. A comfortable balance in the treasury was reported, and assurance was given that current expenses would be easily covered.

From the report of E. W. Farmer, statistician of the national board, the following data made up from incomplete returns from A.S.M.E. code states and cities for 1925 were made available:

Number of boilers in code states	172,319
Number of boilers in code cities	7,112
Number of boilers insured	107,565
Number of boilers uninsured	71,866
New installations	3,759
Boilers found unsafe to operate	896
Boilers found defective and repaired	1,449
Number of boiler explosions	24
Number of boiler accidents	21
Number of pressure-vessel explosions	3
Number of pressure-vessel accidents	10
Total	58
Number of persons killed	13
Number of persons injured	27
Number of state inspectors	129
Number of insurance inspectors	822

On vessels of the merchant marine for the fiscal year 1925 the boiler explosions numbered 19, resulting in ten lives lost and a property damage of $425,703.

From a total of 274 locomotive accidents in 1925, killing 13 and seriously injuring 315, there were a total of 28 boiler explosions, causing a loss of life of 22 and injuring 49.

Charles J. Manney outlined the method of procedure that had been perfected by the Ohio boiler inspection department where a card system is employed to keep track of the work on the 21,000 boilers in active use in the state.

C. D. Thomas, chief boiler inspector of the State of Oregon, made a strong plea for interchangeability of the certificates of competency issued to inspectors. In order that proper classification might be made, M. A. Edgar, chief inspector for Wisconsin, suggested the following definitions for boiler accidents: All minor accidents such as tube ruptures, should be classified as boiler ruptures; boiler accidents of sufficient force to move the boiler off the setting should be termed boiler explosions, and if these explosions entailed loss of life, they should be called major boiler accidents.

Important Papers

"Fatigue of Metals" was the subject of an interesting paper by T. McLean Jasper, director of research, A. O. Smith Corp., in which numerous slides were presented showing the strength of different kinds of steel, variations in endurance values with temperature, the effect on stress of sharp re-entrant angles and of small defects and the indications of fatigue failures.

A complete treatise on applied and internal stresses in the plate, stress distribution around holes and at the calking edge of plates in tension introduced a lengthy paper on "Intercrystalline Cracks in Riveted Seams," prepared by H. Kriegsheim, president of the Permutit Co. Five factors that influence boiler failures, such as the composition of the metal, the work done on it, the temperatures to which it is subjected in manufacture and operation, the element of time and the feed water, were discussed fully. It was pointed out that a certain range of stress and a definite range of temperature were needed for crystalline growth and that hydrogen had a definite embrittling effect on steel. Any one or all of these contributing factors, inducing stresses mechanically or thermally, and particularly the straining of plates at blue heat, might be the cause of the cracks or plate failures. Why seek other causes, such as caustic embrittlement, of which the author would admit no direct evidence?

J. P. Morrison presented an interesting collection of slides showing typical explosions of boilers and unfired pressure vessels, with discussion of causes and results.

Devices Considered

At the final session a number of devices that would contribute to the safety of boiler operation were brought before the convention. One of these was a pressure-equalizing blowoff tank to relieve the shock and danger of blowdown. A safety latch for firing and access doors was on exhibit, and reference was made to a device for scraping the mud and scale off of the shell plate of return-tubular boilers. The blowoff tank and the latch were given unanimous approval.

National Museum Body Re-elects Trustees

The annual meeting of the National Museum of Engineering and Industry, for some time postponed, was held at the Engineering Societies Building, New York, on Friday, May 28, Samuel Insull presiding.

Following reports by officers and committees, the revised constitution was adopted and the present board of trustees re-elected. Anticipating the election of officers, Mr. Insull announced his refusal to consider re-election as president, although he stated his willingness to continue as a member of the board. No meeting of that body was held at this date.

It was with real regret that the trustees learned of the decision of Mr. Insull that he could no longer be responsible for the conducting of the movement. He has been more than generous in its support and it will lack such executive ability as he would give it.

American Boiler Manufacturers Review Need of Modern Plant Equipment and Trade Expansion

Recommendations by President Bach Call for Use of Steel Heating and Ventilating Boilers, Statistics on Production, and Trade Bureau—Annual Report, Election Returns and Resolutions Passed

THE thirty-eighth annual convention of the American Boiler Manufacturers' Association was held at The Homestead, Hot Springs, Va., May 31 to June 2.

In his opening address President George W. Bach cited among the causes of overcapacity in the boiler-manufacturing facilities of the country, the centralization of power plants with its consequent use of larger boiler units operating at much higher percentages of rating and at higher efficiencies, and the more efficient utilization of steam in prime movers as well as in process work.

The boiler output of the country has not been proportional to the growth in population. The facts as to installed boiler capacity, extension and renewals, and the boiler-producing capacity, should be ascertained, and steps taken to extend trade, to absorb surplus capacity or to restrict capacity to probable demand.

Modernization Needed

Boiler users should be educated to the fact that steel boilers are much more efficient and better in every way than cast-iron boilers for heating purposes. The modernizing of industrial power plants should be pushed. It is a recognized fact that the efficiency of three-quarters of the boiler operations of this country could be increased 30 per cent by junking obsolete equipment and replacing it with modern apparatus. Makers of all sorts of power-plant apparatus should unite in impressing the public with the tremendous saving that can be effected in the generation of power and heat.

Examples were quoted of the trade-extension campaigns of other industries. The present method of developing a sales prospect whereby many builders prepare drawings and do expensive engineering and sales work for the same inquirer is an economical waste, as is also the too frequent building to special specifications when standard material would do just as well. Shops should be equipped to make one thing and make it well and cheaply.

Mr. Bach believed that there would be radical changes in boiler design and installation in the near future, particularly in high-pressure boilers of large capacity.

Centralization Here

"The centralization of power is here, and superpower is more than a pet phrase. This centralization of industrial power plants is inevitable, tending toward the elimination of the smaller plant, but developing the possibilities for steam to be used, not only for power but for process work and heating by groups of industries located within distances to which power and steam may be advantageously transmitted.

"The work of standardization and simplification carried on by the boiler industry in co-operation with the Department of Commerce is progressing in the fire-tube field. It is more difficult in the case of the water-tube, which are more specialized in character."

Three recommendations Mr. Bach offered: First, that accurate statistics be gathered and records kept to ascertain what is the total production of the boiler manufacturing business and its decline or growth as compared with the population or that of other industries; second, the establishment of a trade extension bureau that will function in co-operation with the manufacturers of other equipment entering into boiler settings, such as stokers and other major or minor apparatus required for a complete boiler installation for the proper method of carrying on the work of modernizing industrial power plants in the interest of conservation of natural resources and economy in industry; third, that the use of steel boilers for heating and ventilating be increased.

Annual Report

The new secretary, A. C. Baker, was introduced and reported that four companies had joined during the year, making the membership consist of honorary, 2; active 69; associate 29; total, 100. The remainder of the forenoon was devoted to the consideration of reports from the officers and various committees.

On Monday evening F. N. Speller, director of the Department of Metallurgy of the National Tube Works, delivered an interesting address upon Internal Boiler Corrosion. This, with the discussion which was continued until a later hour, will be treated in a later issue.

On Tuesday morning H. N. Covell, who had served the association for years as secretary, but who is no longer connected with the boiler business, was unanimously elected an honorary member.

The death of Clarence Vincent Kellogg, past-president of the association, and of David M. Dillon, one of its earliest members, was announced and suitable resolutions sent to their families and spread upon the records.

Trade Expansion

The forenoon was in large part devoted to a masterly address by Charles F. Abbott, Executive Director of the American Institute of Steel Construction, telling of the trade-extension work that he has done and is doing for the steel fabricators and others, as well as the methods pursued and results obtained by various industries that had adopted modern methods of broadening their markets and extending the use of their products.

Wednesday forenoon was devoted largely to a discussion of the possibilities opened to the boiler manufacturers along the lines of Mr. Abbott's address and the suggestions of the president's address. The Executive Committee was charged with the duty of carrying out a survey of the industry which will furnish the necessary statistical material upon which to proceed in an organized effort for the improvement of conditions. Reports were received from several committees and minor revisions of the by-laws adopted.

Election Results

The election resulted in the choice of the following officers for the ensuing year: President, George W. Bach, Union Iron Works, Erie, Pa., and vice-president, A. R. Goldie, Babcock-Wilcox, Goldie-McCulloch Co., Galt, Ontario, Canada. Those forming the executive committee are: G. S. Barnum, the Bigelow Co., New Haven, Conn.; Joseph H. Broderick, the Broderick Co., Muncie, Ind.; F. G. Cox, Edge Moor Iron Co., Edge Moor, Del.; W. C. Connelly, D. Connelly Boiler Co., Cleveland, Ohio; Owsley Brown, Springfield Boiler Co., Springfield, Ill.; E. R. Fish, Heine Boiler Co., St. Louis, Mo.; J. F. Johnston, Johnston Bros., Ferrysburg, Mich.; M. F. Moore, Kewanee Boiler Co., Kewanee, Ill.; A. G. Pratt, Babcock-Wilcox Co., New York, N. Y.

The social features consisted of the usual golf tournaments, card parties and rides for the ladies and the annual banquet.

Bureau of Standards To Get New Power Plant

A new fireproof power plant for the Bureau of Standards to cost not more than $200,000 has been recommended by the Committee on Public Buildings and Grounds of the Senate. The need for the plant is set forth by the Secretary of Commerce as follows:

"Great economy and facility will be gained from the point of view of operation. An immediate saving of $5,000 a year in personnel alone will be effected; the cost of heating buildings will be reduced 25 per cent, and a potential saving of about the same percentage may be expected on other services.

"The technical administration of the complex plant of the bureau (now extending over a site of 43 acres) will be greatly facilitated in respect to promptness and technical efficiency in adjusting the available services to the constantly varying and exacting needs of the laboratories.

"The new plant will eliminate the costly duplication of power and other equipment when required by several divisions, and at the same time will assure to the 60 or more separate laboratories adequate power and other services of a quality, variety and continuity strictly essential to effective laboratory work, both in testing and research."

"Scientific Effort to Save Oil, Not Law"—Hughes

Encouragement of natural scientific effort, rather than political regulation of production, was suggested as the best oil-conservation policy for the government by Charles E. Hughes, in an address before the Federal Oil Conservation Board, recently published in the *Christian Science Monitor*. The former Secretary of State represented the American Petroleum Institute.

"Political action," he asserted, "is superficially attractive, but difficult and unlikely to succeed. Something might be accomplished by removing legal obstacles to intelligent co-operation. Scientific effort holds the promise of the future. The cracking process has done more for conservation than any legislative scheme could do under our Constitution."

He cited figures to show that the cracking process, by which crude oil is made into gasoline, had doubled the nation's potential gasoline resources.

Overproduction and uneconomic consumption, Mr. Hughes said, are the principal factors operating against oil conservation. There is no actual waste after the oil is produced, he said, but much of it might be kept in the ground.

He pointed out that uses of oil might be restricted, but that this means of conservation could not be practically dealt with by direct legislation; it would have to be an economic restriction, such, for example, as prohibitive prices for fuel oil.

Mr. Hughes declared that federal legislation to regulate production directly would be unconstitutional, and state legislation to this end would be injurious unless it were uniform.

Growth of Canadian Mills Involves Power Increase

The Canadian International Paper Company has put into operation four new 164-inch Fourdrinier paper machines at its plant at Three Rivers, Quebec. With the new equipment, the capacity of the Three Rivers plant is doubled.

Besides the main paper machines, there are also installed 16 additional magazine grinders driven by light 2,600-hp. synchronous motors, making a total in the plant of 30 grinders driven by 15 motors with a total rating of 37,600 hp. The total installed horsepower in motors at Three Rivers is now approximately 50,000 horepower.

Plans have also been made for a new paper mill a few miles east of Ottawa. Four 270-inch Fourdrinier paper machines are to be installed by the latter part of 1926.

The new mill will be operated by hydro-electric power developed on the Gatineau River. Two sites are now being developed and work on the third site will probably commence in the near future. The aggregate capacity being approximately 400,000 kva. of this development, 260,000 hp. will be transmitted to Toronto at 220,000 volts, 25 cycles, over a distance of about 250 miles. The remainder will be used largely at the mill which will operate on 60-cycle power.

Chesney Formally Elected President of A.I.E.E.

Cummings C. Chesney, manager and chief engineer of the General Electric Company's works at Pittsfield, Mass., was elected president of the American Institute of Electrical Engineers at the annual business metting in the Engineering Societies Building, New York, on Friday, May 21. Other officers elected were: Vice-presidents, H. M. Hobart, Schenectady, N. Y.; George L. Knight, Brooklyn, N. Y.; B. G. Jamieson, Chicago; A. E. Bettis,

CUMMINGS C. CHESNEY

Kansas City, Mo.; H. H. Schoolfield, Portland, Ore. Managers, F. J. Chesterman, Pittsburgh; H. C. Don Carlos, Toronto; I. E. Moultrop, Boston. Treasurer, George A. Hamilton, Elizabeth, N. J. (re-elected).

These, together with the hold-over officers, will constitute the board of directors for the next administrative year, beginning Aug. 1.

The annual report of the board of directors, presented at the meeting, showed a net increase in the membership of 839 during the year, the total membership on April 30 being 18,158.

Power Papers on Program of A. I. E. E. Convention

Six technical papers covering electrical engineering in the power field will feature the proceedings on June 24 of the 42d annual convention of the American Institute of Electrical Engineers to be held at White Sulphur Springs, W. Va., June 21 to 26.

As described in the form of reports of technical committees, recent developments in this field will be considered under the following heads, the chairman of the committee reporting:

"Power Generation," by V. E. Alden; "Power Transmission and Distribution," by P. H. Thomas; "General Power Applications," by A. M. MacCutcheon; "Applications to Iron and Steel Production," by F. B. Crosby; "Applications to Mining Work," by F. L. Stone, and "Applications to Marine Work," by L. C. Brooks.

Powdered Coal Explosion at Columbia Station

A slight explosion occurred in the pulverized coal room of the Columbia Power Station, located at Columbia Park, Cincinnati, Ohio, on April 28.

The first indication of trouble was a somewhat minor explosion inside of the conveyor that carried dried coal from the rotary dryers to the pulverizing mills, that blew open the observation doors on the conveyor. This was followed by a puff in the mill room due to igniting coal dust that had been stirred up by the first explosion in the conveyor.

There was no damage to equipment, with the exception that a large steel rolling door in one end of the room, that was closed at the time, was slightly bulged.

After a thorough inspection, the mills were started and within a few hours operation was normal. Operation of the boiler room and other parts of the station was not interfered with.

Operator Dies

One of the operators, who was standing directly opposite an observation door in the conveyor at the time of the explosion had his clothes ignited by fire coming from the conveyor. This man died of burns the following day. Two other men were slightly singed about the face. They were working on different parts of the system and had taken covers off of the conveyor to permit access.

The first cause of the accident has not been definitely determined. The most probable cause is that hot coal or hot ashes from the dryer worked over into the conveyor. The conveyor does not normally contain an explosive mixture of air and coal. However, due to the inspection door on one of the Fuller-Kinyon pump hoppers being open for maintenance work, an unusual amount of air was admitted to the conveyor, which caused an explosive mixture at this point.

Steps Taken to Prevent Recurrence of Accident

Steps have been taken to prevent, if possible, a recurrence of the accident. Shut-off gates are being placed in the system so that any piece of equipment can be entirely shut off from the system for maintenance work. All observation doors are being clamped shut and additional vents supplied from the system to a point outside of the building.

The question of clean working clothes for the men has been forcibly brought to attention by this accident. Union overalls of non-inflammable fabric are to be worn by all men working in the coal preparation house and boiler room. The company will wash all overalls without charge and the usual type of cotton fabric overall will be impregnated after each washing to make it practically non-inflammable.

This power station has just been started and construction work going on at the time, interfered with the proper cleanliness of the coal preparation house. Good "housekeeping" and absolute cleanliness are the prime requisites of safety.

Bright Future for Central-Station Heating Predicted

National District Heating Association Holds Seventeenth Convention at Which Many Interesting Papers and Reports on Boiler-Plants and Central-Station Heating are Presented—Combination Power and Heating Systems Given a Great Deal of Attention

IF THE enthusiasm expressed at the seventeenth annual convention of the National District Heating Association, held at the Niagara Hotel, Niagara Falls, N. Y., June 1 to 4, is a barometer by which to judge the future of central-station heating, then this industry is now entering upon an era of rapid advancement. This convention was the largest held by the association, with about 150 members and guests attending. The five technical sessions were well attended and on every side high hopes were expressed for the future of central-station heating.

President Earle Shultz opened the first session by presenting his report for the year ending June 1, 1926. In this report attention is called to the revival of interest in central-station heating that has come about in the last two or three years, and the way this interest has manifested itself. President Shultz said in part:

"This revival of interest has manifested itself in several ways. In the first place, by an increasing demand on the part of the owners of buildings in the congested districts of the larger cities for the convenience and service of central-station heating. As the result of this increasing demand, a number of large companies have made or are making quite large extensions to existing heating plants, and in one or two cities are developing what practically amounts to entirely new systems. Many electric companies, which have small heating departments that have been the source of considerable loss during the past years, seeing that the large companies are now operating their steam plants on a profitable basis, are now giving thought to the possibilities of doing the same in their localities.

Import Data

"Central station heating is entirely sound in principle, and when the financial and operating problems, which have been holding it back, are completely solved, I believe that its future will be just as prosperous as that of our parent utility, the generation of electricity."

In the report of the Research Committee, Fred B. Orr, chairman, a mass of data was presented on the status of central heating; byproduct systems; characteristics of high back-pressure turbines; heat diagrams; value of electric capacity and energy; proportioning turbines, generators and boilers, determining the annual kw.-hr. output and value of secondary energy; estimating cost of live steam and byproduct steam; exhaust heating in Kansas City; and the proposed exhaust heating system in Detroit.

The committee expressed the opinion that we are in a new era and much thought is being expended in the advancement of central-station heating. New theories are being tested, new methods being applied and the service is becoming a real economic factor.

Byproduct heating systems, conservatively designed, offer attractive possibilities, tending to lower prevailing rates for service or yielding greater net returns to the utilities. In general this type of system is economically possible only by close relations with the local electrical utility; and distinctly ill-advised for independent companies in competition with the electric company. The generating equipment must be able to "float" on the distribution network of a larger electric system for best results.

It is shown in the report that, although the use of electricity supplied by central station has increased about 2,500 per cent since 1902, the use of steam from central heating stations has increased only about 125 per cent. It is also shown that while the rates for electricity have on the average decreased about 50 per cent since 1897, the rates for steam have increased about 150 per cent, reaching a peak in 1920 of about 250 per cent.

Example of Efficiency

In the discussion on this report it was brought out that one large power company was supplying steam for heating and for its turbo-generating plant from the same boilers. In this case the yearly load factor of the power plant was only 26 per cent, where the yearly load factor of the boiler plant was 46 per cent. This meant that the steam could be produced much cheaper than it could be in a plant for each class of service. The combined service plant also has the added advantage that in an emergency the heating load can be temporarily dropped to take care of the power load.

Considerable interest was shown in the combined power and heating plant. In one case where this system is used, the exhaust from the turbine is superheated about 40 deg. so that the average customer receives dry saturated steam. On this system it has been found that the difference between the amount of steam supplied to the heating mains and the amount registered on the customers' meters is less than anywhere else in this country.

The Wednesday evening meeting was devoted to a symposium on recent developments in the future trends of central-station heating, by James D. Hurd, New York Steam Corporation; J. H. Walker, Detroit Edison Co.; Charles H. Day, Cleveland Electric Illuminating Co.; T. E. Purcell, Allegheny County Steam Heating Corp., Pittsburgh, Pa.; R. D. DeWolf, Rochester Gas & Electric Corp.; L. E. Young, Union Electric Light & Power Co., St. Louis, Mo., and J. H. Margolis, Hamburg, Germany. The consensus of opinion was that the future for central-station heating looked promising. To obtain the highest economy, it was pointed out that interconnection of steam-heating systems and electric-power systems was just as important as the interconnection of electric systems. It was predicted that the heating system of the future would consist of a high-pressure and low-pressure system similar to an electric system of transmission and distribution. Turbo-generators will be operated at various points on the system, the turbine taking steam from the high-pressure line and exhausting into the low-pressure system, and the generators connected into the central power system.

A report of particular interest was that of the Station Operating Practice Committee, R. G. Felger, chairman. In this report a paper by Thomas E. Murray describes the fin-tube furnace, in its final development which surrounds the combustion chamber by water-heating surfaces and eliminates the use of refractories. A number of the furnaces are in operation in large plants in this country. A boiler having a furnace completely surrounded by fin tubes is in operation in Manchester, England, and burning pulverized coal, is operating at about 1,500 per cent of rating based on the usual method of rating boilers.

In this report F. B. Wilson tells of a method of using a hand lance having a special head and using cold water for cleaning slag off boiler tubes. When using cold water, the slag breakes off in much larger pieces than with steam and also closer to the tube surface. The reason given for this is that the water requires a longer time to become superheated and reaches the slag at a much lower temperature than if steam were used.

Abstracts of other parts of this report will appear in later issues.

New Brunswick Development To Cost $25,000,000

The harnessing of the water power at Grand Falls, New Brunswick, which has been the subject of considerable discussion and controversy during the last two years, was definitely assured recently as a result of an agreement entered into between the Provincial Government and the International Paper Co. with headquarters at 100 East 42d St., New York City, and the Frasers' Companies, Limited, Edmundston, New Brunswick, according to reports to the Department of Commerce by Assistant Trade Commissioner Walter J. Donnelly, Montreal.

According to the terms of the agreement the International Paper Co. will develop Grand Falls and will erect a pulp and paper plant at a site to be selected. A block of 13,000-hp. primary power and 7,000-hp. secondary power will be reserved for the Frasers' Companies, Ltd., for the proposed 200-ton per day pulp and paper plant to be erected near Campbellton, New Burnswick. The total cost of the project including the construction of the mills will amount to approximately $25,000,000.

Hope Seen for Muscle Shoals Bill As Rider

Members of the Joint Congressional Committee on Muscle Shoals continue to believe that the bill they have recommended will be passed at this session of Congress. While no opportunity will be lost to attach the measure as a rider to any promising bill, Senator Deneen, the chairman of the committee, will insist that the measure is entitled to a place of its own on the legislative program.

When the appointment of the joint committee was before Congress, neither House would brook the slightest interference or delay. The resolution creating the joint committee was put through by what some characterized, at the time, as steam-roller methods. Since two or three of the leaders are not pleased with the recommendation made by the committee, all of the need for action at the earliest moment, of which they talked when the resolution was pending, seems to have been forgotten.

Congress, however, made too much of an issue over prompt action on Muscle Shoals to refuse to consider the report of the committee.

A number of legislators who favor the acceptance of the committee's bill are not particularly anxious to vote on it at this session of Congress. There are elections in the autumn. The question of disposition of Muscle Shoals is a highly controverted one and a vote either way would mean some loss of support.

Senator Harrison, of Mississippi, called attention to the fact that the Senate and the House of Representatives had agreed to refer the matter to a joint committee which has made its report. "The committee's report is here," said Senator Harrison, "and if we are to put off action until December there will be no legislation respecting Muscle Shoals."

Senator Curtis, the majority leader, stated that the bill is among those receiving consideration by the Steering Committee. He explained, however, that it is impossible to foretell what action that committee may take.

Senator McKellar, of Tennessee, introduced a resolution calling upon the joint committee to inform the Senate as to the ownership of the stock of the Muscle Shoals Fertilizer Company and the Muscle Shoals Power Distributing Company. He asks that the actual amounts of the stock owned by the thirteen associated southern power companies be set forth. It happens that the joint committee already had in its possession most of the information sought by the resolution, but some further data are being submitted by the two companies.

Canadian Equipment Shipped For Construction

The Quebec Development Company, builders of the huge power plant for the Aluminum Company of America, in the Lake St. John district of Northern Quebec, has just prepared for a shipment of $2,000,000 worth of equipment for the construction of the dams, canal and power plant.

French Bill To Assist Hydro-Electric Development

An event that may prove to have considerable influence on hydro-electric development in France has just taken place. A bill drafted by the Minister of Public Works and adopted by the Cabinet for presentation to the Parliament purports to assist the financing of hydro-electric development by means of a fund based on a 5 per cent tax on the sale of electrical energy.

The idea of taxing power consumers for the development of new generating facilities is novel and defendable and may solve the difficult problem of the exploitation of the hydraulic resources of the country at a time when the high cost of labor and money have proved almost insurmountable obstacles to hydro-electric extension. For its size and population France is the richest country in Europe and possibly in the world in water power. Yet, in spite of the urgent economic need of reducing imports of coal, hydro-electric development has proceeded at a snail's pace. Of the great projects of the Rhône, Rhine, Dordogne and other basins proposed since the close of hostilities, only a few isolated developments offering maximum chances of commercial success have been attempted, and these have progressed but slowly.

On the contrary, the rapidly increasing demand for power has been met by new steam-plant construction manifestly against the economic interests of the nation. It is expected that the new fund, provided the bill becomes law, combined with such proceeds from German payments in kind in accordance with the Dawes plan as can be assigned to this purpose, will enable hydro-electric development to overcome the handicap resulting from the financial situation.

United Electric Light Co. Opens New Station

A new $800,000 generating station of the United Electric Light Co., located on the Monongahela River, at Braddock, Pa., was opened on May 24, when a dinner attended by the leaders of the Pittsburgh district was served in the turbine room of the building.

The station, which at present has a capacity of 6,250 kva., but which has been designed for an ultimate capacity of 12,500 kva., will operate in serving an area of 40 square miles with a population of 43,000 people.

The present equipment of the station includes three Edge Moor water-tube boilers, fed by Westinghouse stokers, operating at 250 lb., steam pressure, with 125 deg. of superheat. There are two 3,125-kva. Westinghouse steam-turbine-driven generators and Westinghouse surface condensers. One boiler and one turbine are held in reserve for stand-by service. There are also extra transformers and a duplicate transmission line.

Current will be generated at 6,600 volts, three-phase, 60 cycles. This will be stepped up to 22,000 volts for transmission and stepped down to 2,200 volts for distribution.

The building has been so constructed that floods cannot damage it.

Way Clear for Project on St. Lawrence

Development of the water-power possibilities along the St. Lawrence and Niagara Rivers will not be interrupted with in any way by political considerations. This definite statement was made June 3 at a hearing on power applications before the State Water Power Commission, following the publication of reports that politics were going to hold up the granting of any power permits until after election, according to a report printed in the New York *Herald Tribune*.

Furthermore, notice was served on representatives of applicants for the permits that they will have to proceed rapidly with their plans inasmuch as the state commission intends to act promptly on reports on the projects by State Engineer Roy G. Finch. "Within a few weeks or a month" was the time limit set by Attorney General Albert Ottinger.

Hears Power Proposals

The Water Power Commission listened today to plans for sweeping development of St. Lawrence River power by the American Superpower Corporation. The proposals of the American Superpower Corporation are new and differ materially from the original proposals introduced by the company some time ago.

Objection was also made by representatives of the American Superpower Corporation to the granting of a permit to the Frontier Corporation, which has already made application and on whose proposals hearings were recently conducted. E. C. Randall, president of the American Superpower Corporation, claimed that the Water Power Commission has no right to grant the Frontier Corporation's application for a lease based on the preliminary permit for a survey covering this project.

Mr. Randall pointed out that the preliminary permit was made to the Louisville Power Corporation and the St. Lawrence Valley Power Corporation, both of which companies, he said, "had dropped out of sight."

Philadelphia April Output, Central Stations, Smaller

Electric central stations in the Philadelphia Federal Reserve District reported substantial declines in the output of electric power in April, as compared with March, the Federal Reserve Bank of this city reports. Sales of electricity were also reported in smaller volume than in the preceding month. These losses, however, were partly, and in some cases entirely attributable to the fewer days in April.

In fact April sales of electric power to industries showed an actual increase of 2.9 per cent, which indicates a gain of more than 6 per cent, in the average daily consumption by industrial plants. As compared with the previous year production and sales in April, 1926, show large increases, indeed much larger gains than those reported for generator capacity of reporting stations.

Record-Breaking Head For California Plant

Lacking but a few feet of a half-mile, a hydro-electric plant which is being constructed on Bucks Creek, in Plumas County, California, by the Feather River Power Co., will operate under the highest head yet used in the United States. The difference in height between the average forebay level and the waterwheel nozzles will be 2,552 feet.

An unusual feature of the project will be the ratio of storage capacity to yield. At the main Bucks Creek reservoir there is an estimated annual run-off from the water sheds above the dam of 72,000 acre-feet. In order to control this run-off, a storage capacity of 103,000 acre-feet will be provided. The average total yield through the power house will be 114,000 acre-feet per year, and this will produce 205,000,000 kilowatt-hours.

The dam to form the storage basin will be constructed in the wide mouth of Bucks Meadows. It will be 1,220 ft., long on the top, will rise 118 ft. above the stream bed, and will be of the rock-fill type.

The power house will be on the east, or left, bank of the river. The main building will be 105 ft. long, 45 ft. wide and 45 ft. high. In addition, an indoor switch cell room, 70 by 30 ft., will be constructed on the mountain side of the main power house. The slope of the mountain is gradual enough to give the required space without excessive excavation.

The electric power will be generated by two General Electric 25,000-kva., 450-r.p.m., 11,000-volt waterwheel-driven generators.

Another hydro-electric station of record height—second only to the Bucks Creek station—is being constructed in California. This one is the Balch Plant on Kings River, of the San Joaquin Light & Power Corp., with an ultimate static head of 2,470 ft. The first equipment in this station will be a 33,000-kva. 13,200-volt G. E. waterwheel-driven generator. Plans call for four of these units, the largest horizontal generators in this country.

Research Body to Study Better Steel Problem

To meet a world demand for more stamina in steel, scientific research, already under way in England and France, will be started in America, Dr. John A. Mathews, vice-president of the Crucible Steel Company of America, said in an address before the Engineering Foundation at the Union League Club Wednesday evening, May 19.

A joint research committee of the American Institute of Mining and Metallurgical Engineers and the American Society of Testing Materials, according to Doctor Mathews, has mapped out a program of investigations requiring the expenditure of $50,000 and the co-operation of the industries and the universities.

Federal inquiry shows, Doctor Mathews stated, that power plants and turbine designers, valve manufacturers, builders of oil-cracking stills, chemists dealing with nitrogen fixation, furnace designers and others are loudly calling for new materials to stand up under increasingly high temperatures and for more accurate data on the properties of known materials at these temperatures.

"The alloys upon which we must pin our hopes for the most extreme cases of high temperature use, resistance to oxidation and corrosion, are rich in nickel and chromium, together with smaller but substantial additions of silicon, copper, tungsten or molybdenum, or several of them," continued Doctor Mathews.

"Among the applications which will at once occur to engineers are turbine blading, gas-turbine parts, oil-engine valves and auto and aëro engine valves, furnace racks and traveling chain or conveyor parts for either continuous or intermittent high temperatures, carburizing boxes, chemical plant equipment, power-transmission belts for outdoor use, or for ventilating fans in pickling rooms, food containers and hotel and preserving-plant cooking utensils, oil-cracking still plugs, valves, and so on.

"These alloys are of the type known as austenitic. Ordinary steels are austenitic when heated above their critical temperatures, and a very sudden change in properties occurs at these temperatures.

"The fact that these steels are permanently austenitic probably accounts for the uniformity in many of their properties over such a wide range of temperatures as from liquid air to a red heat. Sudden breaks in many of their properties simply do not occur during their useful ranges of use."

"Oil-Power" is the name of a new monthly published by the Standard Oil Co., 26 Broadway, New York City. The magazine is to be devoted to lubrication of machinery and its announced aim is "conservation of petroleum and machinery."

Obituary

Willard G. Carlton, superintendent of power of the electrified divisions of the New York Central Railroad, died at Yonkers, N. Y., on April 15, 1926. Mr. Carlton was born at Warren, Ill., Feb. 20, 1869. In 1892 he graduated from Cornell with the degree of M.E. and went to work immediately for the General Electric Co., where he gained a year's shop experience. In 1893 he joined the Chicago Edison Co. as a draftsman and was soon put in charge of the drafting room. He was engineer in charge of their underground cable and conduit work in 1896 and 1897, and from 1897 to 1901 was also assistant to the chief operating engineer. From 1901 to 1905 he was engineer in charge of designing, constructing and operating. During his twelve years with the Chicago Edison Co. Mr. Carlton was closely associated with W. L. Abbott, now president of the A.S.M.E.

Mr. Carlton had served the New York Central as superintendent of power for twenty-one years. He joined the A.S.M.E. in 1906.

Personal Mention

William W. Bodine is now general manager of the United Gas Improvement Co., Philadelphia, Pa., in addition to his office as vice-president.

Emil Jorgenson has been appointed assistant secretary and assistant treasurer of the Wisconsin Gas & Electric Co., with offices at Racine.

C. E. Bales has resigned as assistant manager of the Louisville Fire Brick Works to accept the position of production manager of the Ironton Fire Brick Co., Ironton, Ohio.

F. A. Hall, formerly in metallurgical work for the New Jersey Tube Co., is now associated with the W. N. Best Corp., 11 Broadway, New York City, in the Dempsey furnace division.

Alfred E. Sorenson, who has been instructor of mechanical engineering at Rensselaer University, has resigned to join the engineering staff at Princeton University.

Major Glen E. Edgerton, chief engineer of the Federal Power Commission, is en route to Europe on a vacation trip. During his absence Major Paul S. Reinecke will act as chief engineer.

Carl H. Sorensen, formerly assistant mechanical engineer of Dodge Brothers, Inc., Detroit, has resigned his position and become associated with the Coon-Divisser Co., of Detroit, in charge of stokers and stoker equipment.

E. D. Johnstone, formerly resident engineer with the Fred. Snare Corp., on the Hudson Avenue Station of the Brooklyn Edison Co., has joined the staff of Thomas E. Murray, Inc., in the capacity of resident engineer on their various activities.

Morgan B. Smith became associated with the General Motors Corporation in the Power & Maintenance Section of the Staff of the Works Managers Committee, on May 1.

Walter P. Schwabe, president and general manager of the Northern Connecticut Power Co., Thompsonville, Conn., has been elected president of the New England division of the National Electric Light Association.

Frank B. Lawton, general superintendent of the Appalachian Electric Power Co., with offices in Huntington, has resigned his position to become assistant manager of the Virginia division of the General Engineering & Management Corp. Mr. Lawton will be located at Charlottesville, Virginia.

Edwin M. Herr, president of the Westinghouse Electric & Manufacturing Co., has been nominated for re-election as a member of the Yale Corporation, Yale University, New Haven, Conn. Mr. Herr will act for a six-year period. He is a graduate of the Sheffield Scientific School, class of '84.

Business Notes

Warren Webster & Company, Camden, N. J., announce the appointment of Lucient J. White as district manager of the company's branch office at San Francisco.

The Sullivan Machinery Co. announces that on June 1 its Northwestern sales office at Spokane, Washington, will be situated at 120 South Lincoln St., Spokane, instead of in the Hutton Bldg., as heretofore.

The R. H. Beaumont Co., 319 Arch St., Philadelphia, announces the opening of a Western branch office at 1544 Strauss Building, 310 South Michigan Ave., Chicago. H. E. Birch, for many years sales manager at Philadelphia, will be in charge.

The Car Fastener Co., Cambridge, Mass., manufacturer of the "Dot" lubricator has disposed of its interests in the automobile and commercial car field, in order that it may devote its efforts to the development of the industrial field entirely.

The Milwaukee Electric Crane & Manufacturing Corp., Milwaukee, Wisconsin, builder of electric traveling cranes and hoists, announces the appointment of W. C. Lloyd, 913 Empire Bldg., Pittsburgh, Pa., as it representative in the Pittsburgh district.

The Cecil R. Lambert Co., Inc., of Detroit, specialists in the design, manufacture and installation of conveying and handling equipment, announces that in order to identify its products and service with its name, the latter has been changed to Mechanical Handling Systems, Inc. The company's facilities for service are being materially increased by additions to its plant and personnel, but there is no change in ownership, management or executive staff.

The Timken Roller Bearing Service & Sales Co., Omaha branch, formerly located at 2524 Farnum St., now occupies larger quarters at 2240 Douglas St. Complete service stocks for authorized distributors will be maintained as in the past. The management will continue under the direction of A. D. Hackim. The new home of the Los Angeles branch will be at 1361 South Figueroa St., moving to this location from 1241 South Hope St.

Coming Conventions

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Annual convention at White Sulphur Springs, W. Va., June 21-25.

American Order of Steam Engineers, W. S. Wetzler, 758 N. 44th St., Philadelphia, Pa. Annual convention at Moose Hall, Philadelphia, June 7-11.

American Society for Testing Materials. C. L. Warwick, 1315 Spruce St., Philadelphia, Pa. Convention at Haddon Hall, Atlantic City, N. J., June 21-25.

American Society of Mechanical Engineers. Calvin W. Rice, 29 West 39th St., New York City. Spring convention at San Francisco, Calif., June 28-30.

American Water Works Association. W. M. Niesley, Assistant to Sec., 170 Broadway, New York City. Annual convention at Hotel Statler, Buffalo, N. Y., June 7-12.

Association of Iron & Steel Electrical Engineers. John F. Kelly, 1007 Empire Bldg., Pittsburgh, Pa. Exposition and convention at Hotel Sherman, Chicago, Ill., June 7-10.

Canadian Association of Stationary Engineers. G. A. Brown, secretary, Major St., Toronto, Ontario. Convention and exposition, London, Ontario, June 29.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. Convention at Atlantic City, begins Sept. 14. Erroneously announced as Sept. 6-11. Annual conventions and exhibitions of state associations are scheduled for the following dates:

New England States Association. Freeman L. Tyler, 32 Briggs St., Taunton, Mass. Convention at New Bedford, Mass., June 16-19; **Ohio State Association.** T. S. Garrett, 2622 E. Second St., Dayton, Ohio, Convention at Newark, Ohio, June 17-19; **Connecticut State Association,** George F. Klopfer, 30 East Pearl St., New Haven, Conn., Convention at Norwich, Conn., June 25-26; **Wisconsin State Association,** R. L. Scott, Eau Claire, Wis. Convention at Milwaukee, Aug. 3-6; **Minnesota State Association, C. A.** Nelson, 800 22nd Ave., N. E. Minneapolis, Minn. Convention at Rochester, Minn., Aug. 4-6; **New Jersey State Association,** S. G. Dalrymple, 111 Hutton St., Jersey City, Convention at Atlantic City, Sept. 12; **Pennsylvania State Association,** Frank J. McCarron, 3647 North 11th St., Philadelphia, Convention at Philadelphia, Sept. 12-13.

New York State Association. Wilmer T. Meinzer, 3626-215 Place, Bayside, Long Island, N. Y. Postponed from June 11 to 12, at Troy, N. Y., to Sept. 12-13 at Atlantic City, N. J.

Universal Craftsmen Council of Engineers. 24th convention and exhibit Milwaukee Auditorium, Milwaukee, Aug. 3-7.

Trade Catalogs

Gears and Speed Reducers—Foote Bros. Gear and Machine Co., 215 N. Curtis St., Chicago, Ill. This latest edition of catalog No. 200 offers far more than is promised by its title, "Gear Problems and IXL Speed Reducers." In addition to a complete catalog section of 392 pages covering gears and reducers, their sizes, capacities, prices, etc., a section over 200 pages in length is devoted to general engineering information, data tables and formulas. The book is well worth a permanent place on the engineer's shelf of reference books.

Safety Treads—American Abrasive Metals Co., 50 Church St., New York City, has just issued a leaflet explaining the use of **Feralun Anti-Slip Treads** in power plants.

Steam Drainage and Boiler Feeding—Morehead Manufacturing Company, Detroit, Mich. General Catalog No. 15, conveniently bound in a standard filing folder, describes the Morehead return steam trap, vacuum trap, condenser trap and other similar specialities and explains their applications.

Water Heaters — Instant Water Heater Sales Division, Inc., 322 South Michigan Ave., Chicago, Ill. Bulletin 526 describes Type-26, copper-tube water heaters designed to use low-pressure steam.

Static Condensers for Power-Factor Correction—Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Static condensers for power-factor correction on motor circuits of 220, 440, 550 volts are described in descriptive leaflet 20286, which discusses the application, construction and installation features of this type of condenser and also points out, with data, the advantages of power-factor correction at the motor.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	May 31 1926
Pool 1	New York	$2.50@$2.75
Smokeless	Boston	1.92
Clearfield	Boston	1.65@ 2.00
Somerset	Boston	1.85@ 2.15
Kanawha	Columbus	1.40@ 1.75
Hocking	Columbus	1.40@ 1.70
Pittsburgh	Pittsburgh	1.75@ 1.90
Pittsburgh gas slack	Pittsburgh	1.35@ 1.40
Franklin, Ill.	Chicago	2.35@ 2.50
Central, Ill.	Chicago	2.00@ 2.15
Ind. 4th Vein	Chicago	2.10@ 2.25
West Ky.	Louisville	1.00@ 1.40
S. E. Ky.	Louisville	1.25@ 1.50
Big Seam	Birmingham	1.75@ 2.25
Anthracite Gross Tons		
Buckwheat No. 1.	New York	1.70@ 3.50
Buckwheat No. 1.	Philadelphia	2.00@ 2.75
Birdseye	New York	1.30@ 2.00

FUEL OIL

New York—June 3, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6½c. per gal. f.o.b. Bayonne, N. J.

St. Louis—May 26, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.10 per bbl.; 26@28 deg., $2.15 per bbl.; 28@30 deg., $2.20 per bbl.; 30@32 deg., $2.25 per bbl.; 32@36 deg., gas oil, 5.9c. per gal.; 38@40 deg., 6.5c. per gal.

Pittsburgh—May 27, f.o.b. local refinery; 30@34 deg., fuel oil, 6¾c. per gal.; 36@40 deg., fuel oil, 7½c. per gal.

Dallas—May 29, f.o.b. local refinery 26@30 deg., $1.70 per bbl.

Philadelphia—May 26, 27@30 deg., $2.31@$2.37 per bbl.; 18@22 deg., $1.93@$1.99; 13@19 deg., $1.68@$1.74 per bbl.

Cincinnati — June 1, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6½c. per gal.; 26@30 deg., 6¾c. per gal.; 30@32 deg., 7c. per gal.

Chicago—June 1, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.30@$1.35 per bbl.; 26@30 deg., $1.40; 30@32 deg., $1.60@$1.65.

Boston—June 1, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.42c. per gal.; 28@32 deg., 5¾c. per gal.

New Plant Construction

Ark., Hot Springs—Army & Navy General Hospital, Constructing Quartermaster, Hot Springs National Park, will receive bids until June 22 for furnishing and installing mechanical equipment in power plant, refrigeration system, etc.

Ark., Marianna — City is having preliminary plans prepared for improvements to waterworks including new pumping equipment, filter plant, ground tank, etc. Estimated cost $100,000. E. P. Douglas, City Hall, is engineer.

Calif., Compton—Los Angeles County Bd., will receive bids until June 21, for improvements to waterworks Dist. No. 9 including pump house, 100,000 gal. tank, etc. near here.

Calif., Modesto — Modesto Refrigerator Co., H. L. and W. F. Beard, 912 11th St., plans the construction of a pre-cooling plant. Estimated cost $140,000.

Conn., West Hartford (Hartford P. O.)—J. Kanter & R. Sinclaire, 338 Asylum St., Hartford, awarded contract for the construction of a 5 and 6 story apartment on North Main Brookside Ave. here to J. Kanter Construction Co., 338 Asylum St., Hartford. Estimated cost $1,250,000.

Conn., Westport — Westport Sanitarium, F. D. Ruland, had plans prepared for the construction of a boiler house. Estimated cost $50,000. A. Kellogg, 89 Franklin St., Boston, Mass., is architect and engineer.

D. C., Washington—A. L. Flint, General Purchasing Office of the Panama Canal, will receive bids until July 1, for Diesel engines and accessories.

Ind., Gary—Gary Land Co., Sixth St. and Broadway, is having preliminary plans prepared for the construction of a 12 story hotel. Estimated cost $2,000,000.

Ind., Indianapolis — Indianapolis Water Co., 113 Monument Circle, plans the installation of a new 7,000,000 gal. centrifugal pump in Washington St. station, also a 15,000,000 g.p.d. turbine driven centrifugal pump at Fall Creek station.

Md., Mount Airy — A. R. Molesworth, mayor and city council, is receiving bids for the construction of a water main, 3,400 ft. long including pumping equipment, electric motor, etc.

Mass., Boston — Quincy Cold Storage Warehouse Co., 133 Commercial St., is having plans prepared for the construction of a power house on Atlantic Ave, T. Wharf. Estimated cost $1,000,000. F. L. Fairbanks, c/o owner, is engineer.

Mass., Watertown (Boston P. O.)—F. B. Gallagher, 276 Stuart St., Boston, Engr., is receiving bids for the construction of addition to power house and equipment including two 1,000 hp. boilers and auxiliaries, feed pumps, superheaters, feedwater heaters, etc., here, for Hood Rubber Co., Nichols Ave., Watertown.

Miss., Lula—City is receiving new bids for one centrifugal pump with 5 hp. motor, one 7½ hp. gas or oil engine, 50,000 gal. steel tank on 100 ft. tower, etc., for waterworks. Southern Engineering Co., Clarksdale, is engineer. Former bids rejected.

N. J., Bayonne—Bayonne Hospital, East 30th St., is having preliminary plans prepared for the construction of a 10 story hospital and nurses' home. Estimated cost $650,000. Crow, Lewis & Wick, 200 5th Ave., New York, N. Y., are architects.

N. J., Newark—Griffith Piano Co., 605 Broad St., is having plans prepared for the construction of a 12 story office and loft building. Estimated cost $850,000. G. E. Jones, 9 Clinton St., is architect.

N. Y., New York—New York Edison Co., Irving Pl., plans the construction of a power house at 118 West 53rd St. Estimated cost $85,000. Private plans.

N. Y., New York — New York Steam Corp.,280 Madison Ave., awarded contract for the construction of a new steam plant initial capacity 30,000 hp., ultimate total capacity 120,000 hp. on East 35th St. to Dwight P. Robinson & Co. Inc., 125 East 46th St. Estimated cost $400,000. Thomas E. Murray, Inc., 55 Duane St., Engr., will receive bids on equipment.

North Carolina—Carolina Power & Light Co., P. A. Tillery, Mgr., Raleigh, awarded contract for the construction of a 76 ft. dam across the Yadkin River, 10 miles south of Albemarle in connection with hydro electric project, to develop 100,000 hp. to Hardaway Contracting Co., Columbus, Ga. Estimated cost including power house, equipment, etc., approximately $8,000,000.

O., Cleveland — Cleveland Electric Illuminating Co., E. J. Cook, Engr. of Construction, Illuminating Bldg., awarded contract for the construction of an electric sub-station at 1931 Walton Ave., to Sam W. Emerson Co., 1836 Euclid Ave. Estimated cost $75,000.

O., Columbus — Dept. of Welfare, Oak and Ninth Sts., J. E. Harner, Dir., will receive bids until June 22, for two 150 hp. boilers for power house at State Sanitarium, Mt. Vernon, O.

Okla., Boise City — City voted $25,000 bonds for the construction of a new electric light plant including oil engine and generator, switchboard, etc., also $18,000 bonds for new waterworks system including deep well pump, etc. Engineer not selected.

Okla., Cherokee—City voted $37,500 bonds for extensions and improvements to waterworks including a 200 hp. Diesel oil engine and generator, deep well and centrifugal fire pumps, etc. Engineer not selected.

Okla., Spiro—City, W. R. Gamble, Clk., will receive bids until June 15, for waterworks improvements including new filtration plant and electric motor driven centrifugal pumps, etc. Estimated cost $40,000. Gantt-Baker Co., 1116 West Main St., Oklahoma City, is engineer.

Pa., Laurelton—Village, H. H. Wolf, will receive bids until June 12 for the construction of a central heating plant including two 300 hp. boilers, etc. G. S. Idell, Corn Exchange Bldg., Philadelphia, is architect. S. A. Jellette Co., 1200 Locust St., Philadelphia, is engineer.

Pa., Philadelphia—Manayunk Plush Co., 109 Levering St., awarded contract for the construction of a dye house, finishing house and power plant at Umbria and Lemonte Sts. to C. M. Swartley & Son, 6835 Ridge Ave.

S. D., Pierre—City is having plans prepared for the construction of a new pumping station, reservoir, etc. Estimated cost $100,000. Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., is engineer.

Texas—Texas Salt Co., c/o G. Leland, Mgr., Houston, will build a plant 150 ton per hour capacity, including air compressors, etc. 14 miles southwest of Houston by day labor. Estimated cost $150,000. Private plans.

Tex., Childress—City voted $35,000 bonds for extensions and improvements to waterworks including pumping equipment, mains, etc.

Tex., Dallas—J. K. Tobin & Associates, c/o Crystal Palace Skating Rink, San Antonio, plans the construction of an ice skating rink including refrigeration system, etc., here. Estimated cost $350,000. Architect not selected.

Tex., Edinburg — City is having preliminary plans prepared for extensions and improvements to water and light plants. Estimated cost $35,000. Machinery for light plant will be required.

Tex., Edinburg — Valley Electric & Ice Co., has acquired light and water plants and plans to expend $250,000 for improvements including new equipment for light plant and a 20 ton addition to ice plant. Private plans.

Tex., Ennis—Ennis Ice Co., c/o J. K. Newcomb, Mgr., will build an ice plant by day labor. Estimated cost $40,000. Private plans.

Tex., Greenville—Naud Burnett is having plans prepared for the construction of an ice plant at Johnson, Pickett and Crockett Sts. Estimated cost $60,000.

Tex., Houston — J. M. West plans the construction of a 28 story office building at Main and Walker Ave. Estimated cost $3,000,000. Architect not selected.

Tex., New Boston—City is having preliminary plans prepared for extensions and improvements to waterworks, including pumping equipment, mains, etc. Estimated cost $25,000.

Tex., Nordheim—Central Power Co., c/o S. M. Udden, Frost Bldg., San Antonio, is having plans prepared for the construction of an ice plant here. Estimated cost $40,000.

Tex., Odem—L. Garrett, plans development of 1,500 acres of land including electric light and water plant, etc. between Portland and Gregory.

Tex., Plainview—M. A. Marcus, 2404 10th St., Wichita Falls, plans the construction of a 15 ton addition to ice plant here. Estimated cost $32,000.

Tex., Plainview—Plainview Ice Co., W. B. Walker, Pres., Paducah, will soon receive bids for the construction of a 15 ton ice plant here. Estimated cost $35,000. Private plans. Machinery will be required.

Tex., San Antonio—Crystal Ice Skating Rink, F. Beddoe, Mgr., is having preliminary plans prepared for the construction of a 15 ton addition to ice plant. Estimated cost $30,000. Private plans. New machinery will be required.

Tex., Vernon—City is receiving bids for one 360 hp. Diesel engine and generator direct connected to a 300 kva. 2,300 v., 60 cycle 3 ph. alternator, with belt driven exciter and switchboard panel.

Va., Luray — Page Power Co., M. E. Roudabush, plans improvements to dam also extensions to plant near here. Estimated cost $150,000.

Wis., Berlin—Wisconsin Power & Light Co., 16 North Carroll St., Madison, is having plans prepared for the construction of a power plant here. Estimated cost $40,000. Bolch & Lippert, Gay Bldg., Madison, are architects and engineers.

Wis., Medford — Medford Co-operative Creamery Co., J. J. Frey, Pres., is having plans prepared for the construction of a dairy plant and power house. Estimated cost $50,000. Kampfer & Buetow, 1380 Blair St., St. Paul, Minn., are architects.

Wis., Shawano — Wisconsin Power & Light Co., 16 North Carroll St., Madison, is receiving bids for complete equipment for hydro-electric plant and dam here. Private plans.

Wis., Weyauwega — Waupaca County, R. M. Hanson, Secy. of Committee, Scandanavia, will receive bids until June 14 for two boilers and grates, two boiler feed pumps, condensate pump, water softener and feed water heater for central power house, etc., here. R. Cramer, 448 27th St., Milwaukee, is engineer.

Ont., Brampton — City plans improvements to waterworks including booster pump, etc. Estimated cost $60,000. A. Riehl is engineer.

Ont., Hawkesbury — Riordon Co., Ltd., Temiskaming, Que., is receiving bids for a new type refuse and coal stoker including 600 hp. boiler for pulp mill on Main St., here. Estimated cost $30,000. H. Anvik, c/o owner, is engineer.

Ont., Toronto—City plans the installation of a new switchboard for controlling motor driven pumps in pumping station. Estimated cost $60,000. R. C. Harris, City Hall, is engineer.

Ont., Toronto—W. Gore, Confederation Life Bldg. and H. G. Acres, Niagara Falls, Consult. Engrs., have submitted report on new duplicate waterworks system. The principal features include a complete pumping station, filtration plant, 12,000,000 gal. reservoir, etc. at Victoria Park, new high pressure pumping station at Sunnyside, both electrical, 50,000,000 gal. reservoir at St. Clair Ave. and Spadina Rd., etc. Total estimated cost $14,317,000.

Ont., Toronto — University of Toronto, Queens Park, awarded contract for the construction of an artificial ice arena to Witchall & Son, 156 St. Helens Ave. Estimated cost $150,000. Artificial ice machinery will be purchased by Harkness, Laudon & Hertzberg Confederation Life Bldg., Engrs.

N. Z., Wellington — Public Works Supplies and Tenders Board, will receive bids until Aug. 24, for one synchronous condenser complete with switch gear and equipment.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

PRICES are fairly steady with demand active for steel pipe, plates, bolts, nuts, and rivets; other items on the steel list are moving slowly. Anti-friction babbitt metal is up 7c. per lb. while linseed oil is 0.1c. per lb. lower, comparing current prices at New York with those in effect a month ago. Quotations on flexible cord in 250-ft. coils and brass-shell sockets have been reduced during the past month. Other materials listed remain firm.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 74c. per ft.
Common, 2½-in., cotton-rubber lined		80c. per ft. list less 40%

Air—Best grade

¾-in., per ft.	3-ply	$0.37½	4 ply	$0.46

Steam—Discounts from List

First grade 30-10%	Second grade 40%	Third grade	40-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50%
Second grade	50-10%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	40-5%
Heavy	30-10%

RAWHIDE LACING
- For cut, best grade, 50%, 2nd grade, 60%.
- For laces in sides, best, 41c. per sq.ft.; 2nd, 37c.
- Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ½ in.	$1.05
Asbestos for high-pressure steam, ½ in.	1.85
Duck and rubber for piston packing	1.05
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.95
Wire insertion asbestos sheet	1.40
Rubber sheet	.60
Rubber sheet, wire insertion	.85
Rubber sheet, duck insertion	.65
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@$2.60 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	13.00@17.50	18.00	15.00@20.00
Colored	10.00@14.00	17.00	12.00@17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.16
New York	.18
Cleveland (per thousand)	36.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.84	$0.98	$0.87

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	$15.25	$15.75	$16.75	$17.25
White	15.25	15.75	15.25	15.75

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, 7/16x1-in. and longer, 19c. per lb., less 50% at New York warehouses. Same discount for tinned. EXTRA per 100 lb. for 1⅛ to 2-in. long, all diameters, 25c.; ⅝-in. dia., 35c.; ½-in., dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, ¾, ⅞, 1 in. diameter by 2½ in. to 4½ in. sell as follows per 100 lb.:

New York	$5.00*	Chicago	$3.50	Pittsburgh	$2.50@2.60

Boiler rivets, same sizes:

New York	$5.20*	Chicago	$3.70	Pittsburgh	$2.90

* For immediate delivery from warehouse.

REFRACTORIES—Prices in car lots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$48@53
Chrome cement, 40@50% Cr_2O_3, in bulk	net ton	23@28
Chrome cement, 40@50% Cr_2O_3, in sacks	net ton	27@32
Magnesite brick: 9-in. straights	net ton	65@68
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50@74.80
Magnesite brick: Soaps and spits	per ton	91.00@95.20
Silica brick: Mt. Union, Pa.	per M	38@40
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	40@47
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@45
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	48@50
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	33@40
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	40@43
Clay brick, 2nd quality 9 in. shapes, Maryland	per M	43@45
Chrome ore crude, 40@50%	net ton	19.00@20.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	75.25
Commercial genuine, intermediate grade	54.00
Anti-friction metal, general service	30.50
No. 4 babbitt (f.o.b.)	13.62½

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.00	$3.90	$3.60
Flats and squares, per 100 lb. base	4.50	4.40	4.10

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	60-10%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	12

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17 07
1¼	.....	.....	19 20
1½	.....	$38 00	17 92
1¾	.....	28 50	20 48
2	$17 33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25 50	42 50	27 04
3¼	30 25	49 50	30 67
3½	31 50	52 75	33 33
4	38 03	67 00	40 11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller, 5c. per cut. 3 in., 9c. per cut
2¼ and 2½ in., 6c. per cut. 3¼ to 4 in., 10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft
No. 14 solid	$33 50 (net)	$ 51 00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:	Lead Covered
Less than coil lots 50%	20%
Coils to 1,000 ft. 60%	30%
1,000 to 5,000 ft. 60–5%	35%
5,000 ft. and over 60–10%	38%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
⅜	$56 50	$61.34	$7.76	$8.83	$4.52	$4.92
½	72 07	78.63	10 21	11.63	6.46	7.03
1	103.31	113 00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167 12	182.79	27.34	30.76	14.56	15.75
2	224 85	245 94	50 13	56.40	19.41	21.01
2½	355 50	388.85	82.03	92 28	27.73	30.01
3	464.88	508 50	218.74	246 10	41.59	45.01
3½	585 30	637.74	483.04	543.46	55.46	60.02
4	714 17	776 30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG, SOLID NEUTRAL OR 2 FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID NEUTRAL OR 2 FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$19.25
No. 16 cotton reinforced heavy		23.50
No. 18 cotton reinforced light		16.00
No. 16 cotton reinforced light		20.50
No. 18 cotton Canvasite cord		15.50
No. 16 cotton Canvasite cord		19.00
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$92.00	*101.20
No. 14 super service cord or similar (2 wire) in 1,000 ft.	133.00	*146.40

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100 amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 60%; 1-5th to standard package, 65%; standard package, 70%.

RENEWABLE FUSES, ENCLOSED—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30	$0.30 ea.	$0.05	100	100
35 to 60	.05 ea.	.06	100	100
65 to 100	.10 ea.	.10	50	50
110 to 200	.15 ea.	.15	25	50
225 to 400	.30 ea.	.30	25	25
450 to 600	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP OR CLEARSITT—

0-30 ampere, standard package (500)	$2.85
0-30 ampere, less than standard package	3.15

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard A type bulbs:

100—130 Volt Watts	Type	Price Each	200—260 Volt Watts	Type	Price Each
Decorative			Special		
15	A 17	$0.27	25	A 19	$0.32
General			50	A 21	.32
25	A 19	.27	100	A 23	.55
40	A 21	.27			
50	A 21	.29			
60	A 21	.32			
100	A 23	.45			

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$6.70	$9.75	$11 60	$18.20
12	10.10	12.60	14 60	23.80
10	13.20	16 40	18 60	30 50
8	19.00	22.30	24 20	42.40
6	.....	.....	34 40	.....
4	.....	.....	48 00	.....
2	.....	.....	68 75	.....
1	.....	.....	94 70	.....
0	.....	.....	115 00	.....
00	.....	.....	138 00	.....
000	.....	.....	165 00	.....
0000	.....	.....	196 00	.....

SOCKETS, BRASS SHELL—

½ In. or Pendant Cap Key Each Net	Keyless Each Net	Pull Each Net	¾ In. Cap Key Each Net	Keyless Each Net	Pull Each Net
$0.17*	$0.15*	$0.22*	$0.20*	$0.18*	$0.25*
.18†	.16†	.23†	.22†	.19†	.26†
.20‡	.18‡	.25‡	.24‡	.21‡	.28‡

* Standard package.
† Unbroken carton.
‡ Broken carton.

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 35c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 37c. lb., 100 lb. lots	35c. lb.
Wire solder, less 100 lb. 29c. lb., 100 lb. lots	31c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N E.C

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole, Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25 to $50 list value	30–5%
$50 list value or over	35%